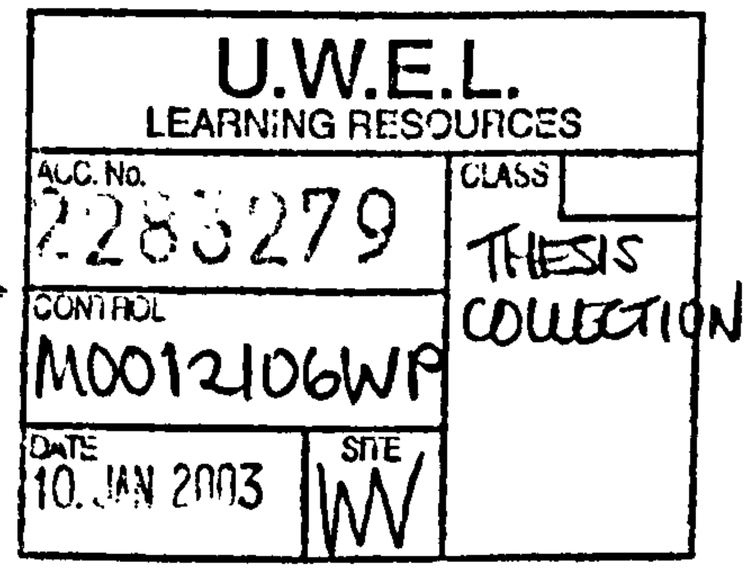
EVALUATING DEVELOPMENTS IN ELECTRONIC COMMUNICATION TECHNOLOGIES AND THEIR INFLUENCE ON BUSINESS PROCESS RE-ORGANISATION

HUSEIN T

A thesis submitted in partial fulfilment of the requirements of the University of Wolverhampton for the posthumous award of Doctor of Philosophy.

June 2002



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UNIVERSITY OF WOLVERHAMPTON

School of Computing and Information Technology

Internal Memorandum

To: **Sarah Capitanio, GSO**

From: **Rob Moreton, Dean, SCIT**

CC: **AS, HDK**

Date: **28th March 2002** **Ref:** **RM/RM**

Taz Husein

As his Director of Studies, I am happy to provide a testimonial statement for Taz. He was an energetic, enthusiastic research student. (His energies sometimes got him into unfortunate 'scrapes'!) He had completed his research except for the write up. This was no easy task for Taz, first because he had just started a new job and second because his written English was terrible!

Because of the latter reason, I have little material of Taz's in my personal files. I used to copiously mark up his drafts and then return them to him for revision. (He used to write as he spoke, with a very convoluted sentence structure. It was always possible to understand his meaning but it did mean he had to undertake several drafts of anything he put down on paper.)

I can confirm that Taz had 'validated' his research in the 4 case organistaions. I had seen the write up of his investigations/activities in these companies, but not the chapters in the thesis. Again, I have nothing on file as 'evidence' for this. In our last discussion we had agreed a schedule for completion of his thesis and had discussed alerting Prof Zairi to his planned completion date.

In his time at Worcester (latterly) Taz had (jointly) published some papers which had nothing to do with his PhD research. I was at pains to point out to him that he was using up time and energy which should have been put into the completion of his thesis. He of course, irrepressibly, felt he was capable of doing both. It became my mantra: "Taz, I only want to speak to you if we can talk about your write up". He is a sadly missed 'character'.

I have made available the articles which were published and the transfer report.

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Review of Taz Husein's work

Dear Dr. Capitanio:

I am happy to provide you with the information I received during my supervision of Taz Husein from conversations with Taz, from his published papers and from his draft papers. Last time I met him was the 18th September 2000 in Wolverhampton. Until this time he published – as I know – the following papers (the recent one first):

1. Husein, T. Moreton, R. Sloane, A. Knöll, H-D: The elicitation process in developing of case library for Case-Based Reasoner system whilst consideration for validating electronic communication technologies. Proceedings of 6th International conference on Information systems, analysis and synthesis, IEEE (Latin America chapter), 22nd – 26th July, Orlando, USA. Vol. 2, pp: 503-507. . ISBN 980 07 6688 X (2000).
2. Husein, T. Moreton, R. Sloane, A. Knöll, H-D.: Utilisation of a process improvement framework (PIF) within small to medium sized enterprises. Proceedings of 4th World Multiconference of Systemics, Cybernetics and informatics, IEEE (Latin America chapter), 22nd – 26th July, Orlando, USA. Vol. 1, pp: 251-256. ISBN 980 07 6687 1 (2000).
3. Husein, T. Moreton, R. Sloane, A. Knöll, H-D.: A matrix of evaluation and comparison of Case-Based Reasoning (CBR) software tools to facilitate understanding and appreciation. Proceedings of 3rd World Multiconference of Systemics, Cybernetics and informatics, IEEE (Latin America chapter), 31st July - 4th August, Orlando, USA. Vol. 3, pp: 334-339. ISBN 980-07-5914-X (1999).
4. Husein, T. Moreton, R. Sloane, A. Knöll, H-D.: An evaluation of BPR methodologies adopting NIMSAD: A systematic framework for understanding and evaluating methodologies. Proceedings of 5th International conference on Information systems, analysis and synthesis 99, IEEE (Latin America chapter), 31st July - 4th August, Orlando, USA. Vol. 1, pp: 205-213. ISBN 980-07-5912-3 (1999).
5. T. Husein, R. Moreton, A. Sloane, H.-D. Knöll: A Process Improvement Framework for Small to Medium Sized Enterprises Taking into Consideration Electronic Communication Technologies. 4th intntl. UKAIS Conf., University of York, UK (1999).

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6. T. Husein, R. Moreton, A. Sloane, H.-D. Knöll: An Expert System utilising Case Base Reasoning technology, to provide assistance to small to medium size enterprise to analysis their requirements of electronic communication technologies. 5th itntl. Conf. on Information Systems, Analysis and Synthesis ISAS'99, Orlando, FL (1999).
7. T. Husein, R. Moreton, A. Sloane, H.-D. Knöll: A Process Improvement Framework for Small to Medium Size Enterprises taking into Consideration Electronic Communication Technologies. UK Academy for Information Systems, York, UK (1999).

As you can see, it have been well established journals and conferences, where his contributions (co-authored by his supervisors) have been accepted and published. It might bee that I am not aware of all his published papers.

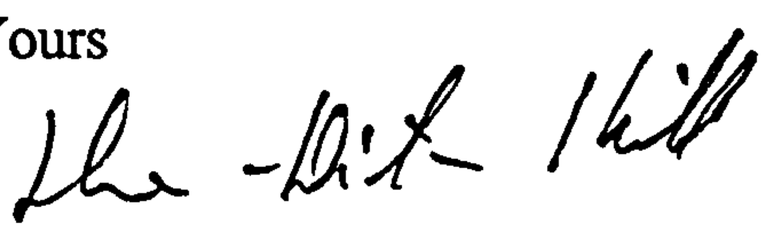
On that specific day in September 2000 we discussed how he could now bring his work to an end. We discussed the proceeding and outline of his case studies already in earlier meetings. He was just recovering from his heart attack and had to make a break for an other month. Now we were talking about a specific case (his fourth) which he had evaluated already and to write down to include it into his roughly prepared PhD report.
Before that specific meeting I was not sure that he would be able completing his thesis within a year, but after that conversation I was convinced he would deliver it by May, if there was no further obstacle by his health.
His work was sound, the methodology innovative, and his approach to evaluate the case studies driven by his deep knowledge of the matter.

I, from my perspective, strongly recommend the posthumous award of a PhD to Tazmmal Husein.

If you have further request I will be happy to answer.

With kindest regards

Yours



Prof. Dr. Heinz-Dieter Knoell

University of Wolverhampton

School of Computing and Information Technology

Electronic communications technology (ECT) and its influence on business process re-engineering (BPR).

Tazmmal Husein

Transfer report from Master of Philosophy to Doctor of Philosophy.

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ABSTRACT

The first part of the report introduces the subject of business process re-engineering and electronic communication technologies. It discusses the impact of the high rate of change in technology and working environments in an organisation particularly small-to-medium sized enterprises (SMEs) and the role of business process re-engineering in enabling enterprises to regain competitiveness and profitability. This section also discusses the importance of the implementation of electronic communication technologies in enabling SMEs to become more successful in their business activities.

The second part of the report discusses the major aims of the research and identifies the objectives set to achieve these aims. These objectives are summarised in this section and are then discussed in greater detail during part 3 "research activities". The research activities include the definition of a BPR evaluation framework and the specification and development of an ECT analysis tool (using expert system technology). Recommendations for further work are given in part 4. Part 5 provides the references utilised within this report. Part 6 (appendices) of the report includes the comparison matrix of BPR methodologies, a project management plan for the period of 1995-98, the diagrammatic representation of the framework, questionnaire on BPR or CPI, and comparison of BPR and CPI.

1.0. INTRODUCTION

"Change is the actuality of the potential *qua* such" (Aristotle)

Given the high rate of change in technology and working environments, enterprises are under tremendous pressure to improve their effectiveness. Globalisation of business, internationalisation of trade and the increasing prevalence of multi-culture interdisciplinary teams are beginning to redefine the nature of office work. Enterprises need to, therefore study themselves to determine what should be changed (Vogel & Glasson, (1995); Grover, V et al (1993)). Many enterprises have evolved to the point where the structure and procedures are no longer in keeping with the needs of the future (Regan, 1995; Zwass, 1996). Small to Medium Size Enterprises (SMEs) are a major and growing provider of employment and can play a vital role in economic regeneration (Beaver & Harris, 1995). However, they should not be treated like small versions of large enterprises because they have a significant number of attributes, which makes them different from larger enterprises (Petric *et al*, 1996). Some of these attributes are; little or no formal administrative structure, less formal organisational structure, limited access to resources or expertise and limited financial resources.

Industries today are being compelled to change by either technological or socio-political developments (Champy, 1995), throughout the world, access and availability of information together with electronic communication technologies (ECT) is beginning to generate a new business paradigm. This is becoming as significant and far reaching as those of the past industrial revolutions such as Adam Smith's 18th century articulated principle "division of labour or specialisation of labour" or early

20th century evolutionary steps of "repetitive task" introduced by Henry Ford or Alfred Sloan's concept of "mass production". This revolution is based on effective utilisation of available communication technologies to convey information and to use it strategically; to re-organise business processes to satisfy customer perspectives; to gain competitive edge; and to accommodate, as well as respond to, changes quickly and effectively. Recent years have seen businesses benefiting from a significant amount of changes in the telecommunications environment, which have occurred mainly in the area of network services, including Fax, Electronic Mail (e-mail) Electronic data interchange (EDI), hence forming an integral part of the Electronic Commerce (EC). However, the business response to these changes is typically a reactive acceptance without any due consideration for structural change.

The convergence of key technologies such as telecommunications, broadcasting, Information Technology and publishing are beginning to form a single electronic world-wide information market place in which the use of information and knowledge is becoming the key to economic and social development (Cannon et al, 1997). Consequently, an amalgamation of these forces has contrived a fresh world for commerce and the nature of the innovation is such that, the business information system (IS) and the processes of business itself are now candidates for redesign in the light of this emerging technology.

Electronic Commerce (EC), is sharing information, maintaining business relationships, and conducting business transaction by means of telecommunications (Zwass, 1996). It is the application of information technology to support the business processes, the exchange of goods and services which promises to radically transform

business (Kambil, 1997). It is a modern business technology that addresses the needs of organisations, markets and consumers to cut costs while improving the quality of goods and services and increasing the speed of service delivery (Kalakota & Whinston, 1996). It is a business strategy that seeks specific business goals which needs a variety of Information Technologies for the purpose of transforming the relationships between businesses and opening new market opportunities (Pickerill, 1993). The move towards Electronic Commerce is driven by four primary forces: - the increasingly Global nature of business; the growing inter-organisational and co-dependency of companies with a value chain; the need to control costs; and the desire to provide superior customer services. It has been estimated that by the year 2000, business conducted through electronic commerce will exceed approx. 25 billion pounds per year (Lucas, 1997).

Business Process Re-engineering (BPR), as suggested by (Hammer, 1995), involves the fundamental rethinking and radical redesign of business processes to achieve dramatic improvement in critical, contemporary measures of performance such as cost, quality service and speed. Though work in the field of BPR emphasises the need for a synthesis between business and technology, previous studies have failed to recognise the fundamental nature of electronic communication and its influence on the business environment.

For the smaller or medium sized company, it is often thought that restricted company size or the protection afforded by home markets will inevitably minimise the impact of the globalisation on process a business redesigned performance. However, even SMEs can be seen to substantially suffer or benefit from the direct or indirect affects

of globalisation (Cannon, *et al*, 1997). e.g. increased competition from Far East into the market which SMEs are competing in the home market. Hence SMEs will quickly fail if they do not perceive or acknowledge the impact that environmental change have on their business (Kitchen & Proctor, 1995). Therefore as suggested by (Beaver & Harris, 1995), to optimise both business development and competitive advantage, it is of paramount importance that the contribution of contemporary, relevant and focussed technologies which enable Electronic Commerce are maximised so that the future development of economic growth, prosperity and employment choice can be achieved

With these rapid advances in information technologies, in particular Electronic Communications Technologies (ECT), many organisations are now trying to use new technology to make themselves more successful (Probhu *et al*, 1994, Ramarapu, N.K. & Lado, A., 1995). Hence Business Process Re-design/Re-Engineering has become the main issue for companies to regain competitiveness and profitability (Scneer & Fruse, 1994; Tardier, 1994; Wastell, 1994 and Kepaen 1994).

A fundamental need of managers who want to improve their enterprises' performance is to know how they operate. This requires an understanding of their organisation's business processes (Regan, 1995). It has been suggested that many companies are aware of the possibilities that Electronic Commerce can provide, but are afraid to adopt it as a medium for doing business (Bradesko, 1995). The cost of implementing such technologies has been continuously dropping and is now easily within affordable reach of SMEs. This reluctance of accepting these technologies by SMEs to implement have been widely documented and analysed (Garcia-Sierra *et al*, 1994;

Hoogeweegen & Wagenaar 1995; Meier & Suhl 1995; Gebauer, 1995; Parker & Swatman, 1995). The reluctance to accept these technologies is due to: - lack of awareness regarding these technologies; a fear-based culture, financial constraints and protection of home market. If SMEs are to therefore be encouraged to incorporate technologies such as ECT and Multimedia it is important that a reasonably inexpensive, thorough and easy to apply Business Process Re-engineering (BPR) framework is available to guide the businesses through these changes.

2.0. THE AIM AND OBJECTIVES OF THE RESEARCH.

The aim of this research is to develop a simple, cost-effective but thorough Business Process Re-engineering framework that can be easily utilised by Small to Medium Sized Enterprises (SMEs). This will enable them to incorporate Electronic Communication Technologies (ECT) into their operational processes to become more competitive in an ever-increasing global market. It is the intention of the research to produce a tool that can be used to provide a detailed analysis of electronic communication technology, which then can be used by SMEs to select appropriate technologies.

To achieve these aims, the following objectives were set: -

2.1. Literature review:

A detailed review of business process re-engineering and its role as a key issue for SMEs to regain competitiveness and profitability in increasingly volatile markets; along with the impact of electronic communication technologies to make this possible will be undertaken. The factors responsible for the changes in the business environment over the last few years will also be identified.

2.2. Evaluation of BPR Methodologies:

An evaluation of BPR methodologies using NIMSAD, a systematic framework for understanding and evaluating methodologies. The purpose of this will be to establish what construes a simple, in-expensive but thorough BPR methodology.

2.3. Design of a Framework:

A BPR framework will be designed with particular attention to electronic communication technologies analysis which can be easily utilised by SMEs.

2.4. Design of an electronic communications technology analysis tool:

An expert system will be constructed from the literature on ECT and cases where ECT has been implemented to carry out business processes. The attention will be to create a database of cases to make comparison of culture factors and technology, so as a feasible and appropriate solution could be provided by the expert system. The out come will be a pull out of likely benchmarked case(s) and list of technologies, that may be implemented by SMEs to re-organise their current business processes.

2.5. Coding of the expert system:

Various technological solutions will be investigated including objected oriented languages, for example Smalltalk or C++ are most applicable; or alternatively which is the most feasible CBR shell.

2.6. Case study analysis

Finally, a case study analysis: involving an enterprise with an existing communication infrastructure with an internal and external clientele, which will be carried out to establish the efficacy of the BPR Framework and the ECT analysis tool.

The BPR framework and ECT analysis tool will be evaluated in terms of: -

a) performance as a cost-effective and thorough method to analyse SMEs business processes;

b) adaptability to be used in other business sectors;

c) ability to perform in comparison to an established BPR framework;

Objectives 2.1,2.2, 2.3, and 2.4 are seen as fulfilling the requirements for the MPhil. Phase of the research project. Objective 2.5 and 2.6 is recommended for further work for this research, leading to PhD. Level.

3.0. RESEARCH ACTIVITIES

3.1. Literature Review

An extensive literature review was undertaken and the following factors affecting change in the business environment were identified: -

- Globalisation;
- Technological development and advancements;
- Demographic changes;
- Short product development time scale and lifecycle;
- Competition from developing countries;
- Consumer demands for higher quality services.

Their influence and impact on small-to-medium sized enterprises (SMEs) within the United Kingdom were analysed.

The role of Business process re-engineering (BPR) and its ability to enable changes within the business environment within SMEs were analysed. Current and future technological innovations in the form of electronic communication technologies were identified and the business context required for their effective exploitation was investigated. An examination of the interaction between the communication tools and the process of business were also analysed.

It was established from the analysis that BPR was a viable option that should be considered by SMEs to reorganise their processes to become more efficient and

effective in a competitive market. It was also identified that the use of ECTs should also be used at every opportunity to enable business processes to operate more effectively.

3.2. Publication

This section reports on an academic paper, which was published in the Journal of Management Studies in 1996. It summarises the contents of the paper and its importance as part of the MPhil stage of research.

An academic paper entitled "Electronic commerce: A consideration of implementation for SMEs." was submitted and published in Vol. 5 No. 1 1996 of the Journal of Management Studies. The paper describes the various benefits that could be attributed to electronic communication technologies and their importance as an effective tool in an enterprises competitive strategy. The paper was developed from an extensive literature review and the underlying reasons why SMEs are unwilling to implement such technologies was outlined. The paper also attempted to highlight the major components that contributed to the slow rate of acceptance of ECT and the benefits which enterprises stand to gain from their widespread adoption.

3.3. BPR methodology analysis.

BPR has become the key issue for companies to regain competitive edge in an ever-increasing global market. Recent years have seen a remarkably high increase in the number of commercially available methodologies to support its implementation. However it has been recognised that in practice a methodological approach is often

not used (Chatzoglou & Macaulay 1996), and because this popular approach appears to lack clear articulation (Probhu *et al*, 1994).

A methodology should be a formal structured, general-purpose approach to the solution of a particular type of problem (Kellener, 1995), and should be an explicit mechanism for helping to solve problems. However, once there is more than one methodology for solving similar problems, an additional problem of choice is created (Jayaratna, 1994).

A methodology comparison will hence provide a structured means of selection and will serve to provide evidence that the initial selection was correct or that other more appropriate methodologies exist (The Object Agency Inc., 1995). There are however problems associated with methodology comparisons and in an attempt to avoid these problems, it is suggested that the following is undertaken: -

i. use an appropriate framework from which to conduct the evaluation;

ii. undertake a thorough review and research of the methodology including manually searching for varied terms which should then be quantified;

iii. ensure that the definition of the methodology utilised is neither overly constrained or unconstrained.

It was therefore decided to use NIMSAD (Normative Information Model-Based System Analysis and Design), a general framework which was derived from problem solving in industry, consultancy practice and active research. This can be applied to the analysis of any methodology and serve as a way of understanding the area of

problem solving in general. It also helps to evaluate the methodologies' structure, steps, formalisation etc.

Five Methodologies were chosen on the basis that each claimed to be able to successfully and radically improve organisations business processes. The methodologies included in the comparison were chosen from varying backgrounds. These are as follows: -

Coopers & Lybrand (BreakPoint methodology). A proprietary methodology.

ICL Fujitsu Ltd. (ProcessWise Methodology). A proprietary methodology which has become available commercially.

Rank Xerox (RXUK Methodology). An in-house Methodology.

Process analysis and design methodology (PADM Methodology). An academic research based methodology.

ESRC (Executive Systems Research Centre) Methodology. An academic research based methodology.

The results of the comparison can be found in the appendices.

It was established from the comparison that the strongest methodologies in all aspects of BPR were those which are commercially available i.e. BreakPoint from Cooper & Lybrand and ProcessWise from ICL Fujitsu Ltd. Unfortunately these were also the most expensive of all the methodologies under review and in all probability too expensive to be utilised by SMEs. Cost being the determining influence in which methodology SME can adopt.

The less expensive methodologies i.e. ESRC and PADM, which could more realistically could be afforded by SMEs, unfortunately often lacked strength in many important areas of BPR and they also have very little details in documentation.

It was therefore determined, that if SMEs are to be encouraged to incorporate technologies such as ECT and Multimedia it is important that they do undertake BPR to establish their needs, an inexpensive, simple and thorough framework needs to be designed so as to utilise BPR.

From this comparison a new BPR framework taking Electronic Communication Technology into consideration was designed in an attempt to provide an inexpensive and simple but thorough alternative for SMEs to utilise, to maximise the incorporation of an appropriate ECT to enable them to compete more effectively.

3.4. The development of framework.

The life cycle of the framework specified has the potential to involve all stages from strategic analysis through to the continuous process improvement (CPI) of the re-engineered process. The framework therefore follows an iterative life cycle. A Diagrammatic representation of the model is included in the appendices.

3.4.1 Phase 1. The identification of process/processes requiring CPI or BPR.

The first phase of the framework is divided into two stages: Initiation and Investigation.

3.4.1.1. STAGE 1 INITIATION

The objectives of this stage are to identify the reason for reorganisation, the level of process activity and the process(s) requiring reorganisation. These objectives are achieved by the following 7 steps.

1. Identify reason for reorganisation.
2. Identify level of process activity.
3. Select team
4. Identify business process.
5. Identify business drivers
6. Identify what the market place has to offer.
7. Identify operating requirements.

3.4.1.1.1. Step1

The reasons why an organisation may be required to reorganise its processes will vary and therefore before any action can be taken to tackle problems within existing processes these reasons need to be identified so that a plan of action can be implemented. Having established the reasons why changes are necessary, it can then be determined which level of process activity is best suited to solve the business problem.

3.4.1.1.2. Step 2

For an organisation to survive in today's competitive environment, improvement is not an option but a necessity (Hammer M. (1994); Martinsons, M. 1995). For organisations that seek to thrive, small incremental improvements are always necessary, however, occasionally the only key to success is dramatic improvement. However, this involves the ripping apart of a process and rebuilding it and this may not always be necessary. Continuous Process Improvement on the other hand aims to achieve incremental, continuous improvement resulting in the streamlining of a process in the pursuance of continuous customer satisfaction. CPI aims to enhance the existing situation and only looks at what is required to attained the desired performance requirements and not the business as a whole.

Hence, both CPI and BPR have a place in today's organisations and CPI should actually be a mainstay in every organisation. BPR on the other hand is necessary at certain times in certain situations at which time CPI is not adequate for the job. (Chang, 1995) Both CPI and BPR are necessary to drive significant advances in organisational performance, but they differ in a number of ways. These differences are summarised and the summary is included in the appendices.

To establish which level of process activity is required a questionnaire has been designed taking into account key considerations that have been outlined by Chang, (1995). The questionnaire is intended to be completed by the project facilitator and was developed specifically for the research project (adapted from one suggested by Chang, 1995). The questionnaire is included in the appendices.

3.4.1.1.3. Step 3

Having established what level of process activity is required, the next step is to select a team of people who will drive the effort. The most important issue at this stage is the decision regarding team size and structure. This will vary according to which level of process activity is to be employed. The CPI team will tend to involve employees at all levels involved with the process led by a facilitator. The BPR team will tend to involve a team of experts, a management committee and task teams (Regan, 1995) because process reengineering often leads to changing organisational structure and redesigning jobs.

3.4.1.1.4. Step 4

Once a team has been identified the next step is to establish the process(s) which require reorganisation. A process is a series of steps designed to accomplish a goal, they are three dimensional, linear in that they have starting and finishing points. They have width based on the number of departments involved and they have depth determined by the level of detail at which the process is documented. In addition processes have customers, beneficiaries and are driven by business, management and customer requirements (Regan, 1995.)

3.4.1.1.5. Step 5

Processes are the infrastructure of an organisation and are the primary pipeline through which corporate work flows. Successful re-engineering projects realign their processes to satisfy customer demands. However, before determining what the customers want it is necessary to identify whom the customers of the process are. This is achieved by listing any external and internal customers who are either effected by the process or who depend on the process for information, products or service.

Having identified the customers the next step is to identify what the customers require of the process to be re-engineered. This may include requirement areas such as timeliness, cost, accuracy, quantity, price, availability etc. At this point a questionnaire can be designed that relates to the areas that concern the customers. This should then be distributed to the customers aiming to gather sufficient information to enable the measurement of customer needs and expectations. If possible, the interviewing of customers after the distribution of the questionnaires will aid the process re-engineering effort.

3.4.1.1.6. Step 6

Once the business drivers have been identified the next important step to take if possible is that of benchmarking. Benchmarking involves the learning and discovery of how other work groups perform common processes or how other competitive or best performing organisations operate. This can be achieved by a number of methods such as, surveying other organisations by phone, subscription programmes, literature review or visit other organisations to observe and analyse the running of their processes. Benchmarking will assist the reengineering effort because it will identify

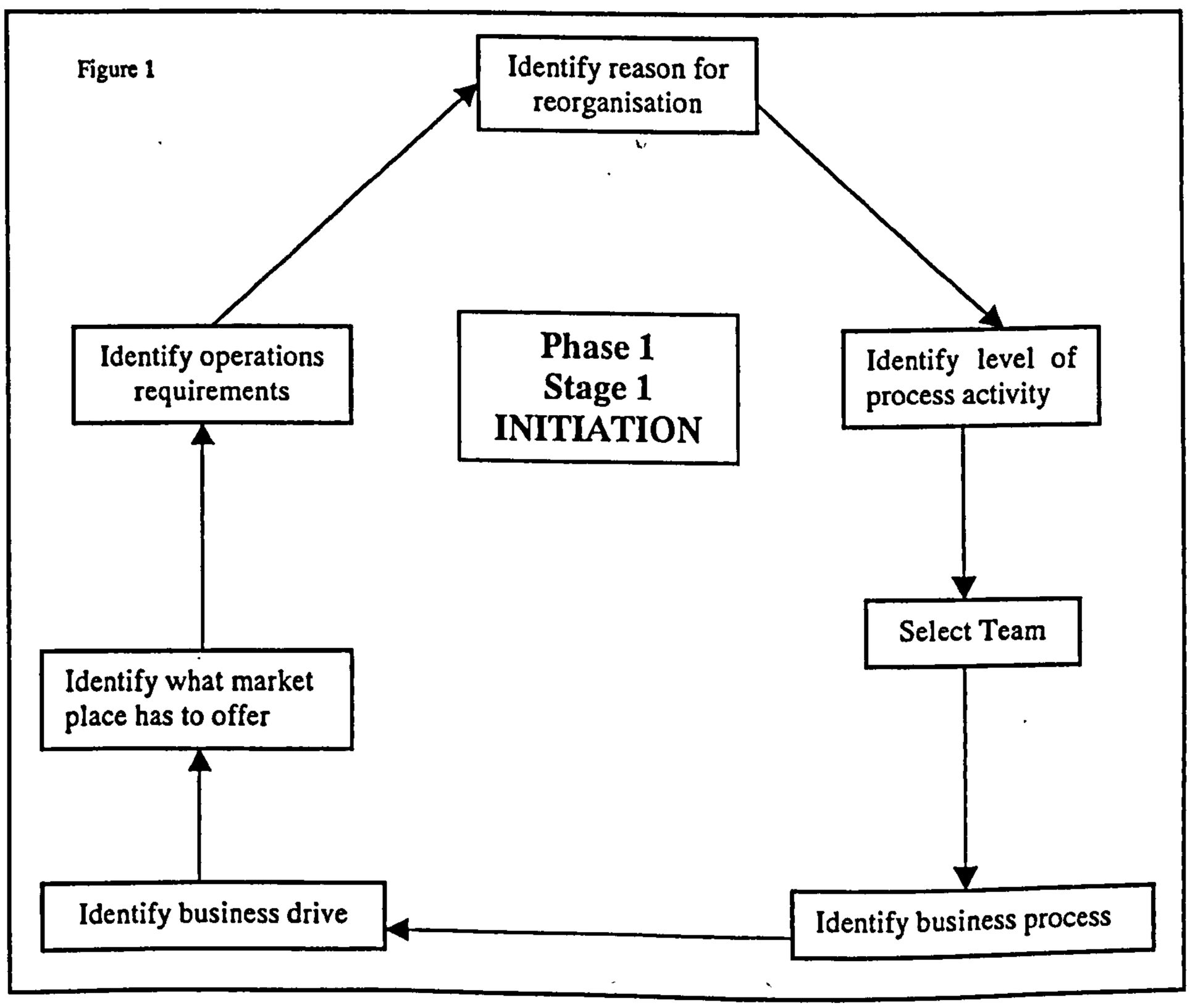
what the market place has to offer and where you stand compared to your competitors.

3.4.1.1.7. Step 7

The final step of this phase is to identify the operating requirements i.e. what needs to be achieved to meet the wants and demands of those driving the reengineering effort. This step will result in the identification of what the process should do, based on the customer and marketplace information gathered.

On completion of Stage 1 the decision of whether to CPI or BPR will have been established and the process(es) requiring change will have been identified. The steps to achieve this are summarised in figure 1.

Figure 1



3.4.1.2. STAGE 2 INVESTIGATION

The objectives of this stage are to understand and measure the existing processes, envisage a desired state and identify weaknesses in the current performance of the processes. The following steps achieve these objectives;

1. Analyse existing process

2. Identify weaknesses

3. Visualise new process

3.4.1.2.1. Step 1

Unless it is known how the existing process is performing it is impossible to state with any degree of certainty whether or not process re-engineering will benefit the organisation. The first step therefore is to document the "as is" process by defining and mapping out all of the tasks involved in the process. This will provide a clear and realistic view of the process. To document the process two basic steps should be undertaken. The first is to list all of the major process tasks. The input and the output involved in the process should be determined and everything in-between will be the tasks involved. Once the major tasks have been identified the smaller subtasks and decisions that link the major tasks together should be determined. The second step is to then create a process flowchart, which will allow visual interpretation of what happens in each step of the process

3.4.1.2.2. Step 2

Having listed the major process tasks and documented them in a process flow chart the process can then be measured to gather performance data. This will identify areas

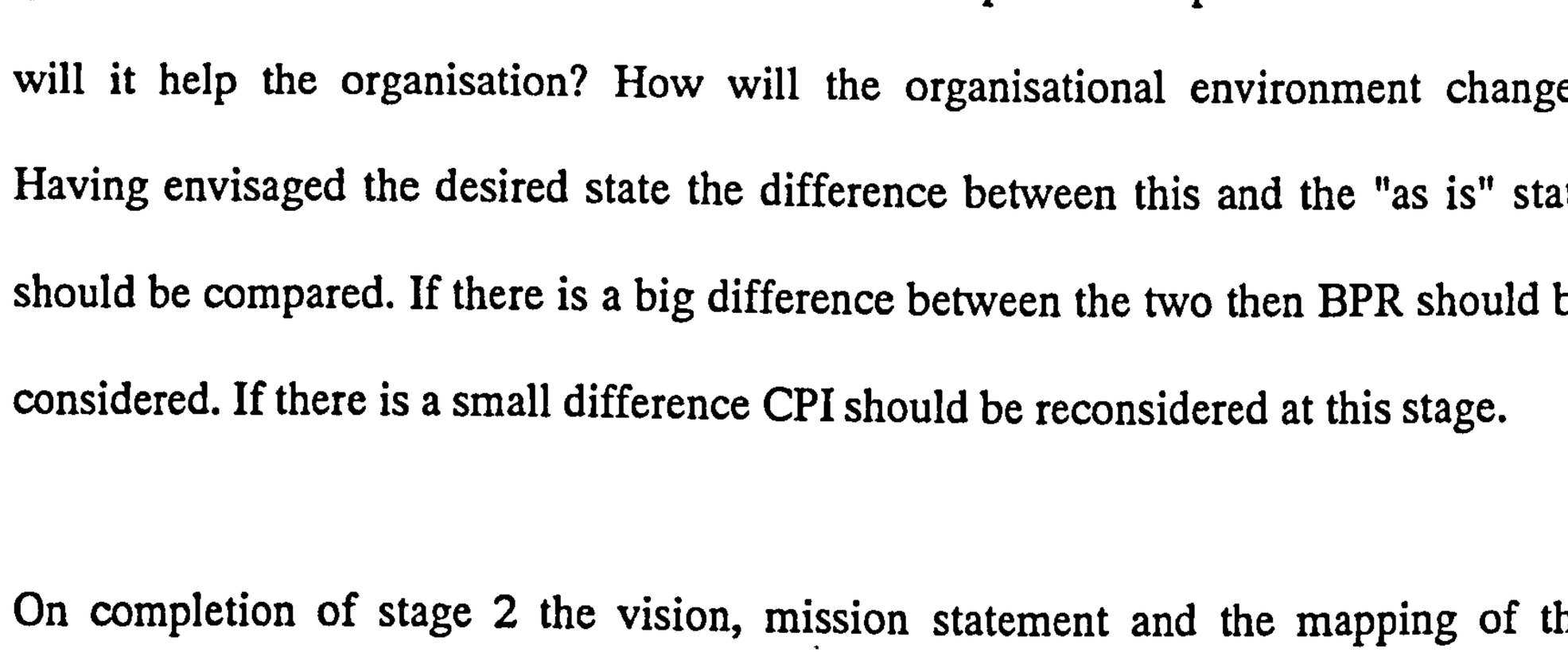
of weakness and where improvements can be made. The data gathered will depend on what needs to be measured e.g. the cost of the whole process or the time it takes to undertake each task. It is therefore important to gather data on each task of the process identified.

3.4.1.2.3. Step 3

This step aims to envisage what the new process will look like. It focuses on what the new process could be and what it could accomplish. During this step the following questions need to be addressed. How will the new process help the customer? How will it help the organisation? How will the organisational environment change? Having envisaged the desired state the difference between this and the "as is" state should be compared. If there is a big difference between the two then BPR should be considered. If there is a small difference CPI should be reconsidered at this stage.

On completion of stage 2 the vision, mission statement and the mapping of the current process will have been achieved. This is summarised in figure 2.

Figure 2



Phase 2 of the framework involves the two stages of design and implementation.

3.4.2.1. STAGE 3 DESIGN

The objective of the design stage is to provide a detailed model of the re-engineered process resulting in a prototype. The following steps achieve this objective:

1. Identify solutions to the weaknesses/problems identified in stage 2.

2. Create a new process flow chart

3. Redefine the process support requirements

3.4.2.1.1. Step 1

During this step solutions to the weaknesses identified during stage 2 should be identified. This can be achieved by utilising the process design alternatives worksheet as described by Chang, 1995. This involves listing each key task of the process and describing how that task is currently being completed. The next step is then to identify alternative methods of undertaking the same task. These methods must be realistic and take into account the customers requirements and what the competitors provide. From here a feasibility report should be submitted.

3.4.2.1.2. Step 2

Having identified feasible solutions a new process flow chart should be created. The mapping of the "ideal" process will result in a practical application of the planning effort. This step can be time consuming but it is important to be thorough to ensure success.

3.4.2.1.3.Step3

This step aims to redefine the process support requirements including people, technology and finance. During this step certain questions should be asked. These

include: can the process be made simpler? Can technology help? Can time and/or cost be reduced?

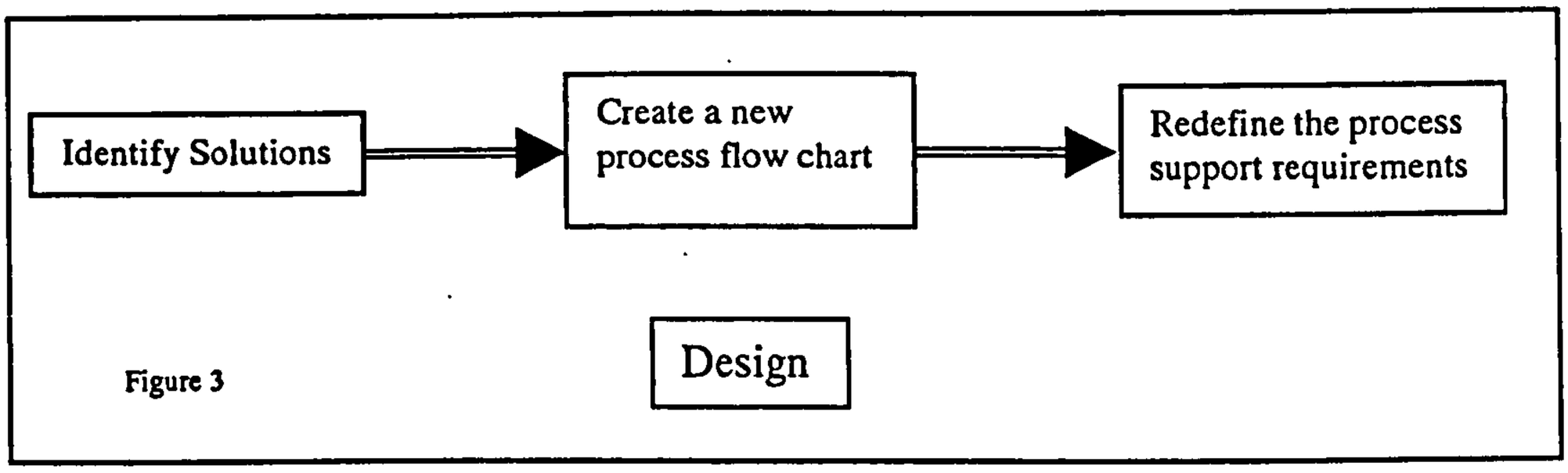


Figure 3

Process re-engineering includes a human element and therefore any impact the new process will have on people needs to be identified. By listing the present and future responsibilities of each job role, will provide information on new job requirements and training needs.

New technology especially that of electronic communication technology can have a large impact on the success of an organisation. During the design stage of the framework it is of paramount importance that such technologies are considered for implementation. The growing numbers of different ECT is vast and therefore makes it difficult to make decisions on what to implement. This can therefore be achieved during this step by utilising an ECT analysis tool in the form of an expert system to establish appropriate and suitable ECT, which can be utilised to maximise the potential of the re-engineered process.

Finally, a cost-benefit analysis should be undertaken during this step to determine whether it is advisable to proceed to the next stage of implementation. The impact of the re-engineered process on the organisation should also be considered during this step.

On completion of this stage a new management plan will have been documented and the prototype of the reorganised process will have been developed ready for implementation. The above steps I have summarised in figure 3.

3.4.2.2. STAGE 4 IMPLEMENTATION

This stage involves the implementation of the prototype i.e. the redesigned process. The objectives of this stage are to ensure the appropriate emplacement and adequate operation of the new process. The following steps achieve this objective:

1. Pilot trial
2. Education
3. Changeover

3.4.2.2.1. Step 1

Before full implementation is considered a thorough pilot trial should be considered to ensure that the proposed changes would enhance the process. Once the trial has been concluded it is important to establish the success of the new process. Data should therefore be gathered on the new process to determine whether the changes meet the desired goals. On completion of this step it should have been identified whether it is safe to proceed to full implementation or whether adjustments need to be made first.

3.4.2.2.2. Step 2

Before full implementation can be made all education needs should be met. These should have been identified and addressed during the design stage and completed by this stage.

3.4.2.2.3. Step 3

The final step in the implementation stage is that of changeover to the new re-engineered process. During this step the new process should be standardised to enable acceptance and establishment within the organisation. The new process should then be documented along with the new guidelines.

The final product of stage 4 should include a fully implemented, standardised re-engineered process. The above steps of this stage are summarised in figure 4.

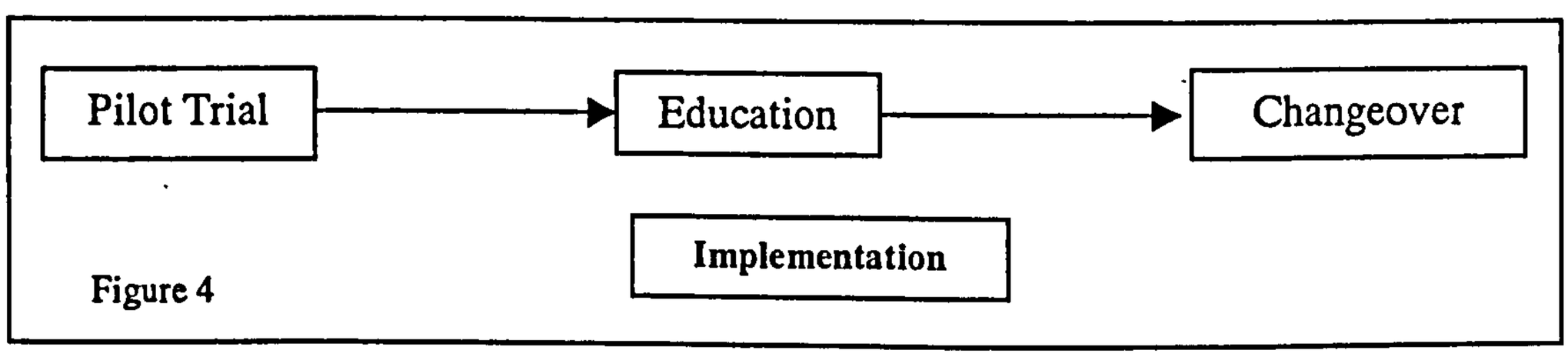


Figure 4

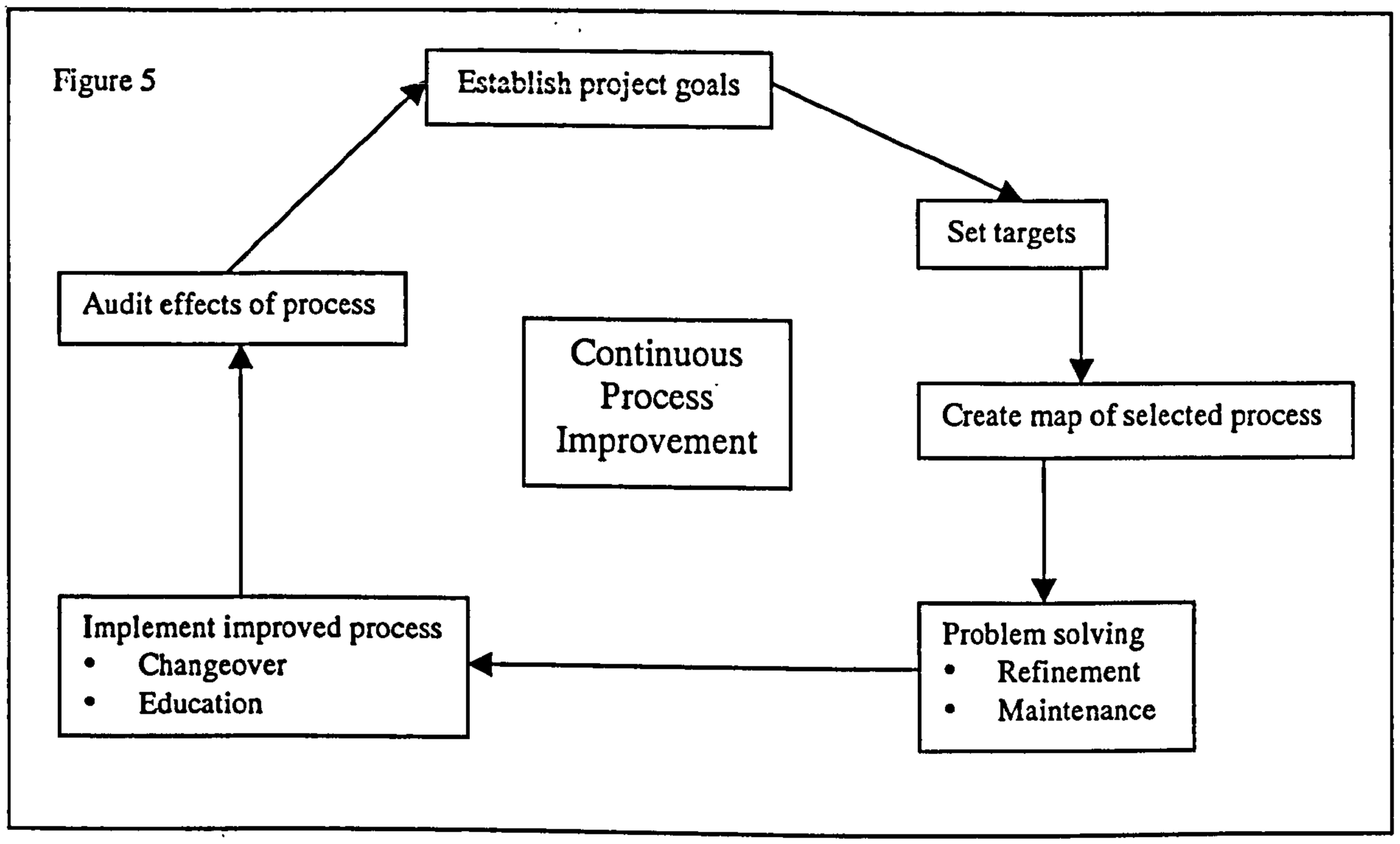
3.4.3 Phase 3 Continuous Process Improvement (CPI)

The final phase of the framework involves the management of the reorganised process and incorporates Continuous Process Improvement. Here the application of tools designed to achieve incremental, continuous improvement in process cycle-times and added-value contributions, with emphasis on the elimination of waste and bureaucratic elements, the over-riding objective being to streamline processes in the pursuance of continuous customer satisfaction.

This type of project is usually initiated for a number of reasons:

- to meet the demands of a business plan;

- to meet the demands of a performance target;
- to support a corporate initiative;
- to aid the success of a quality scheme.



The process effort often focuses on cost factors or the elimination of waste aiming to maximise the process and ensure its continuing improvement.

3.4.4 CPI framework

The framework is team based, which is co-ordinated by a facilitator, provided with the project goals and a set of targets from which the group builds process maps and looks at target-related elements and areas. The projects only look at what needs to be achieved to attain the desired performance requirements, not the business as a whole.

The focus of the CPI method is to enhance the existing situation and a process map is created from which improvement opportunities are identified. Any maintenance and refinements required will be identified during the problem solving stage. During the implementation stage the education of process owners/users will be undertaken before changeover. Finally, the selected team will monitor an ongoing audit of its effects. The stages of the CPI methodology I have are summarised in figure 5.

3.5. Design Of ECT Analysis Tool.

The market for Business Process Re-engineering (BPR) tools is estimated to be at hundred million pounds and is growing at 40% or more per year (Kleinberg, 1995). There are now a wide variety of BPR tools, which assist in a number of aspects of the BPR methodology. These include tools that will analyse new business processes and assist in providing training and education.

Electronic commerce is at the cutting edge for business today and the factors fuelling the avid interest in electronic communication technologies run the gamut of business processes (Kalakota & Whinsten, 1996). It is considered that electronic commerce is well suited to facilitate the current re-engineering of business processes and that the broad goals of re-engineering and electronic commerce are remarkably similar.

The emergence of new and innovative technological advances are appearing at a remarkable rate and will probably continue to do so, and with this the decision of which technology to utilise will become more and more difficult especially for small-to-medium sized enterprises.

It was therefore, decided to develop an electronic communication technology analysis tool which could be used within the BPR framework to establish which technology or technologies would be most suited to assist in the more efficient and effective running of business processes. The basis for the development of the tool was to be an expert system.

3.5.1. Expert system

An expert system is a computer program that represents and reasons with knowledge of a specialist subject with a view to solving problems or giving advice (Jackson, 1990). The expert system is informed about a particular situation of concern to a user, which is usually achieved by the user answering questions posed by the system, this system then provides an expert advice concerning that situation.

Expert or knowledge based systems (KBS) are one of the success stories of Artificial Intelligence (AI) research. There are more the two thousand KBS in commercial operation, many of them in manufacturing industries (DTI, 1992). However, despite the undoubted success of knowledge-based decision support systems in many sectors, developers of these systems have met several problems: -

- knowledge elicitation, a difficult process, often being referred to as the knowledge elicitation bottleneck;
- implementation, implementing KBS is a difficult and tedious process, which requires special skill and it often takes many years before it is fully functional. Once implemented KBS are often slow and unable to access or manage large volumes of information; and they are once implemented they are difficult to maintain (Watson & Marir, (1994)).

However over the last few years a reasoning paradigm and computational problem solving method that seems to address the problems identified above has increasingly attracted attention. Case-Base reasoning (CBR) solves new problems by adapting

the DOS environment (crystal expert system), previously was knowledgeable in its use.

3.5.2. Expert system as the basis for an ECT analysis tool

The market for Business Process Re-engineering (BPR) tools was recently to be at hundreds of million pounds and is growing at 40% or more per year (Kleinberg, 1995). There are now a wide variety of BPR tools, which assist in a number of aspects of the BPR methodology. These include tools that will analyse new business processes and assist in providing training and education.

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3.5.3. Expert system technology

At the heart of an expert system is a computer program that represents and reasons with knowledge of some specialist subject with a view to solving problems or giving

advice (Jackson, 1990). An expert system is informed about a particular situation of concern to a user, which is usually achieved by the user answering questions posed by the system, the system then provides an expert advice concerning that situation.

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- knowledge elicitation, a difficult process, often providing a bottleneck to system development;
- implementation, implementing KBS is a difficult and tedious process, which requires special skill and it often takes many years before it is fully functional.
- once operational KBS are often slow and unable to access or manage large volumes of information; and they are once implemented they are difficult to maintain (Watson & Marir (1994)).

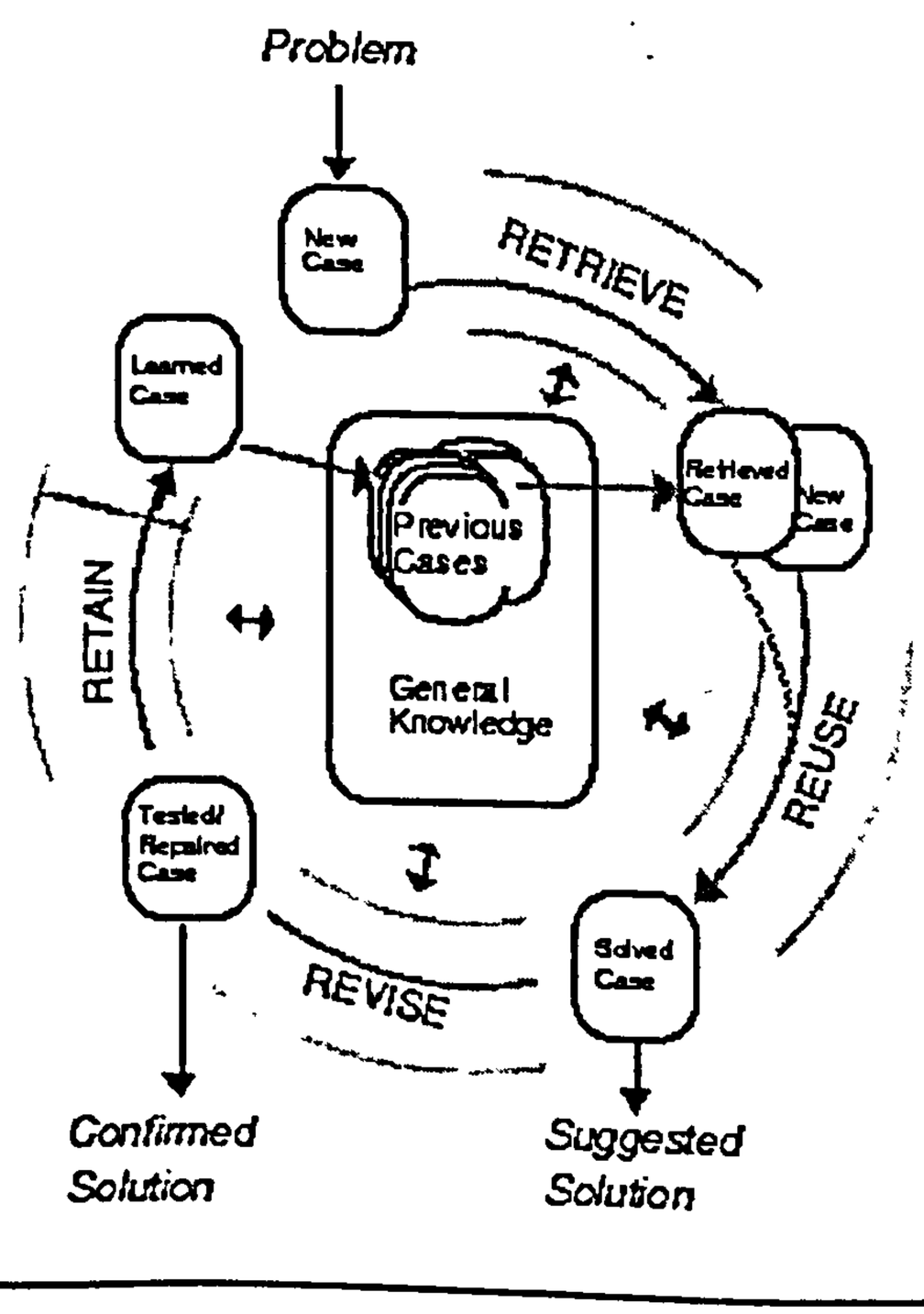
However over the last few years a reasoning paradigm and computational problem solving method that seems to address the problems identified above has increasingly attracted attention. Case-Base reasoning (CBR) solves new problems by adapting previously successful solutions to similar problems (Aamodt & Plaza, (1994); Kolodner, J.L. (1993)). The advantages CBR provides can be summarised as:

- CBR does not require an explicit domain model and so elicitation becomes a task of gathering case histories;
- Implementation is reduced to identifying significant features that describe a case, an easier task than creating an explicit model;
- by applying database techniques, large volumes of information can be managed;
- maintenance and updating is easier as CBR systems can learn by acquiring new cases at intervals.

The process involved in CBR can be represented by a schematic cycle, see figure 6 (Aamodt & Plaza, 1994). It is a cyclical process, which involves the following activities: -

5. retrieve the most similar case(s);
6. reuse the case(s) to attempt to solve the problem;
7. revise the proposed solution if necessary;
8. retain the new solution as a part of a new case.

Figure 6



When developing CBR an appropriate tool, shell or language needs to be selected. An Expert system shell was chosen as this enable the system to be built quickly and cost-effectively. An expert application shell was chosen because of its availability within the university's School of Computing and Information Technology (SCIT). It was chosen because the author, having used an expert system shell based in the DOS environment (crystal expert system) previously, was knowledgeable in its use.

3.5.4. CBR as the basis for an ECT analysis tool

It was decided to use an expert system as an Electronic Communication Technologies Analysis Tool (ECTAT) because it was identified that SMEs are reluctant to implement ECT as a result of their lack of knowledge and their general understanding of the benefits available in this particular area (Hoogeweegan & Wagenaar, 1995, Amos & cooper, 1995). The expert system is therefore an easy and cost-effective tool that can be used by SMEs to identify appropriate ECT and provide expert advice in this subject and hence assist in the decision making. A discussion with a fellow research student, who is using CBR as a tool to facilitate ethical understanding (Rahanu, H. (1998), suggested and provided an initial idea for the development of this CBR tool for this project. The suggestions and ideas by the fellow research student, along with literature published on this subject by a variety of authors for example (Aamodt & Plaza, 1994, Watson, 1997), were analysed and adapted to suit the necessary criteria required to develop an ECT analysis tool in the form of CBR. The rationale of this adaptation is presented in a schematic diagram in figure 7.

business process(es). The information gathered in this way will form the basis for the source case library.

The library of the source cases will be indexed to enable speedy retrieval of data. The indexing will be predictive in that it will address the purpose the case will be used for. It will also be abstract enough to allow for increasing the scope in the use of the case library.

The retrieval of appropriate source cases will be achieved using the nearest neighbour (NN) retrieval technique. This is a simple technique that provides a measure of how similar a target case is to a source case.

Once a matching case is retrieved the CBR system will attempt to reuse the solution suggested by the retrieved case. If the solution for the retrieved case is appropriate this will be confirmed and used as required. However in certain circumstances the solution to the retrieved case may not be entirely appropriate and in this situation the CBR system must adapt the solution. Adaptation is suitable in many situations but is not essential. Watson (1997) has suggested that adaptation should only be used if it can easily be carried out, using simple and well-understood parameters, adjustments or reinstantiations.

An alternative solution is to use the CBR to determine if a similar adaptation has been used in the past and if so, is it utilised? Otherwise, a person is asked to perform the adaptation, as the case will be for this CBR.

The target case problem, (see figure 7) describes the current environment in terms of :

-

(i) Nature of business and its processes;

(ii) organisational structure and management;

(iii) current ECT usage;

(iv) business system objects e.g. lowering costs, increasing in productivity etc.

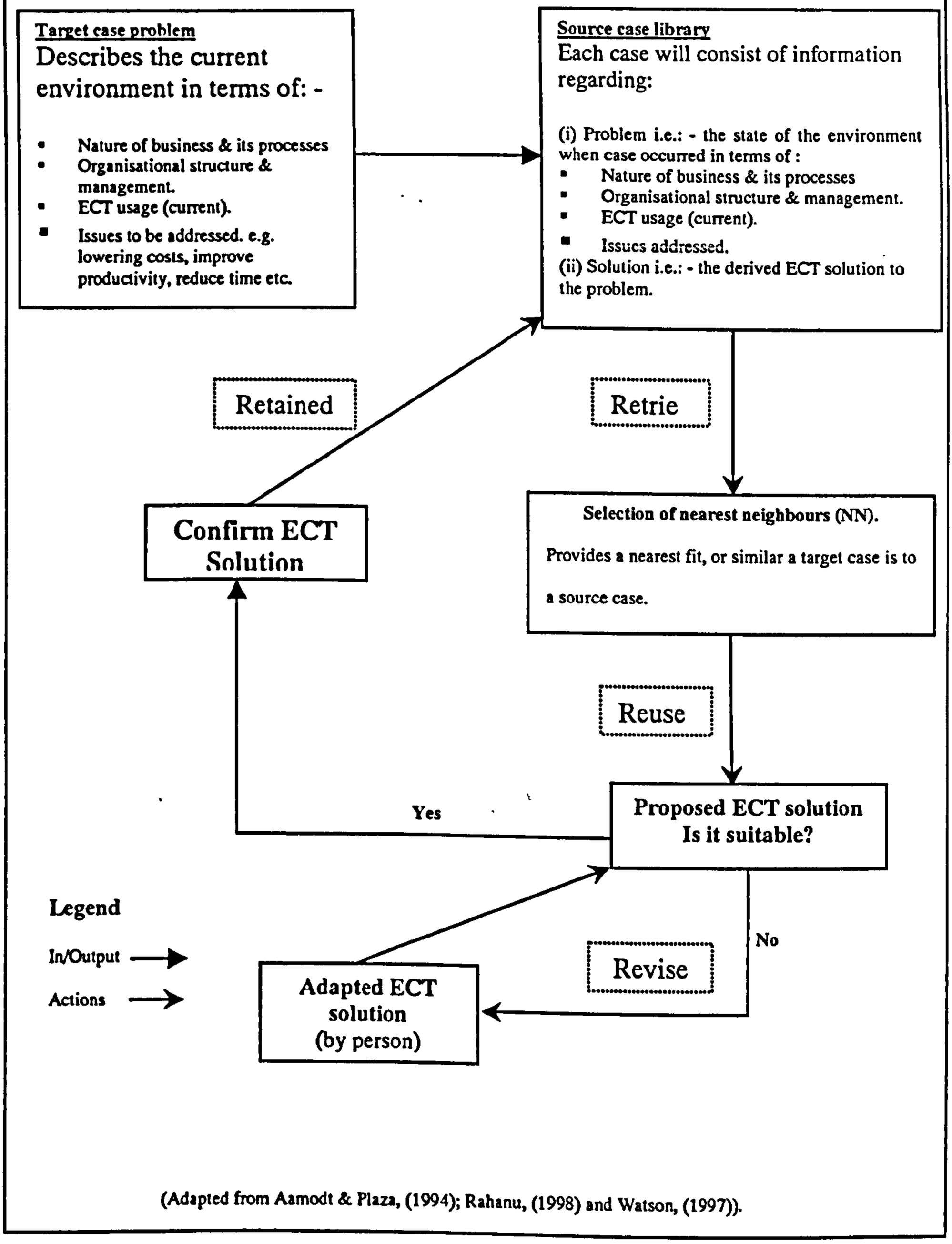
The above is then matched against source cases which are held in the source case library. Each source case will be represented by the problem space i.e. the state of the environment when the case occurred in terms of above criteria and by it solution space i.e. the derived electronic communication technologies (ECT) solution to the problem.

The source cases will be collected by means of a postal questionnaire. An initial questionnaire will be sent to a number of small to medium sized enterprises (SMEs) within the UK, and will aim to establish their current business environment and their use of ECT within their business processes. This will include details of their business and its processes, their organisation structure and management, current and planned ECT usage and any issues regarding the specific implementation of ECT to assist with business processes.

The returned questionnaires will then be analysed to identify potential source cases, i.e. cases which have specifically implemented ECT to assist with their business process(es). These selected SMEs will then be sent a further questionnaire, which will consist of more detailed questions regarding the use of ECT and its effects on

Case Based Reasoning (CBR): An ECT analysis tool

Figure 7



(Adapted from Aamodt & Plaza, (1994); Rahanu, (1998) and Watson, (1997)).

4.0. PROPOSALS FOR FURTHER DEVELOPMENT OF THE RESEARCH

The aim of this stage of the research is to code the ECTAT, the schematic representation that is given in the figure 7. The second stage will be to apply the BPR framework and ECTAT to a case study and develop business strategy guidelines for major electronic communication developments.

The case study will focus on a SME in the manufacturing sector. A range of business process(es), identified by applying the BPR framework will be reengineered by utilising ECTAT. Upon completion of the case study the effectiveness of the model will be evaluated in terms of: -

- Its appropriateness in determining applicability of ECTs to SMEs;
- its performance as a cost-effective and thorough method of analyses SMEs business processes;
- its adaptability to be used in other business sectors;
- its ability to perform in comparison to an established BPR methodology.

The application of the model will then be extended to develop a critical evaluation of current business processes in a variety of SMEs. This will accomplished by collecting a number of case studies that reflect business diversity.

The Framework will then be developed into a more generalised approach, which will be reapplied, to other possible case studies across a number of businesses within the UK. At this stage, the CBR will be evaluated, particularly of its usability.

5.0. REFERENCES

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6.0. APPENDICES

A. Research Time Plan.
B. Schematic representation of the methodology.
C. Methodology Comparison.
D. Comparison of BPR and CPI.
E. CPI or BPR Questionnaire.

Research Plan for the period of 1995-1998

M.Phil. 17-22 months, **Ph.D.** 9-14 months

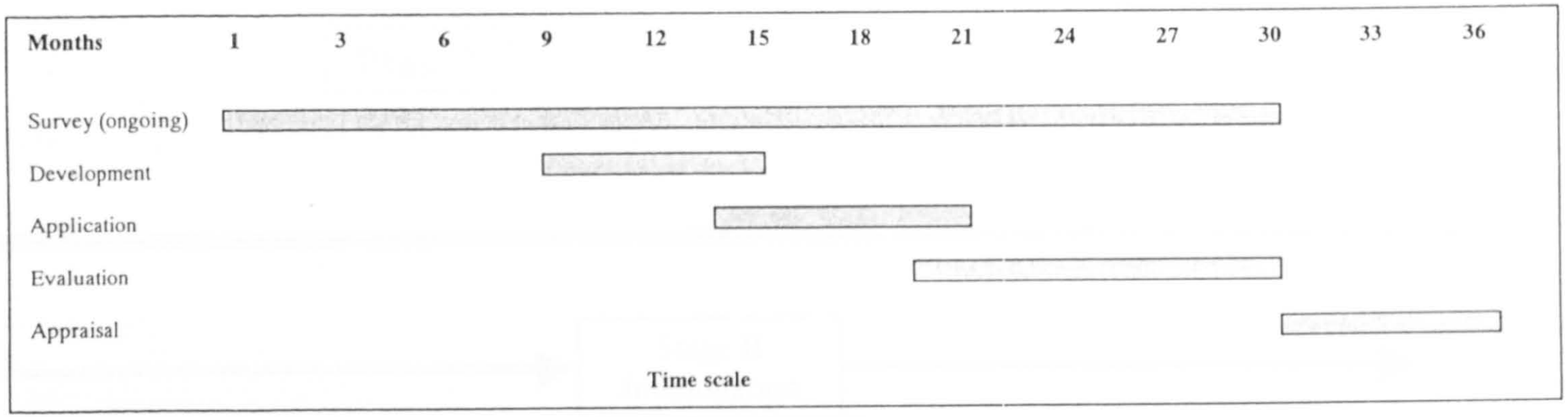
Research Program

M.Phil.

Survey Of ECT and associated BP.
Develop Model of ECT's interaction with IS and BP
Select and apply model to case study.
Develop business strategy guidelines for major ECT development.

Ph.D.

Evaluate model and develop generalised approach.
Re-apply generalised approach to other cases across number of business sectors.



Activities

Literature review

Survey of electronic communication technologies and their associated business process.
Identify and form a reasoned assessment of the impact of various technologies on the business information system and business process.

Model and Framework

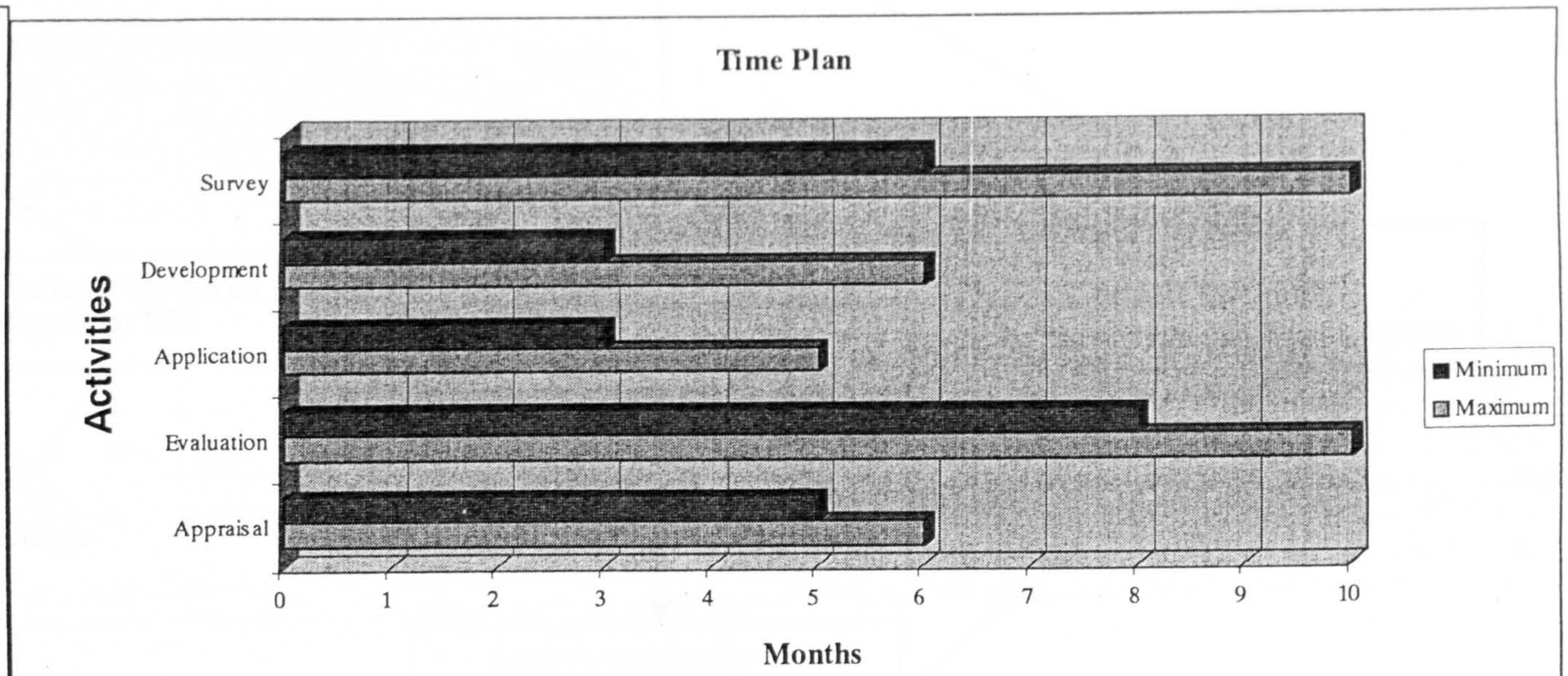
Develop model of electronic communications technologies's interaction with information systems and technology planning.
Develop evaluation framework of the model to be used for the purposes of business and technology planning.
Apply model to a case study, develop business strategy guidelines for major electronic communication technologies development.

Evaluation

Extend the application of the model to develop a critical evaluation of current business in variety of businesses.
Evaluate the model and develop a generalised approach.
Re-apply the generalised approach to other cases across a number of business sectors.

Appraisal

Provide an appraisal of the effect of electronic communication technologies for the current and future innovations.



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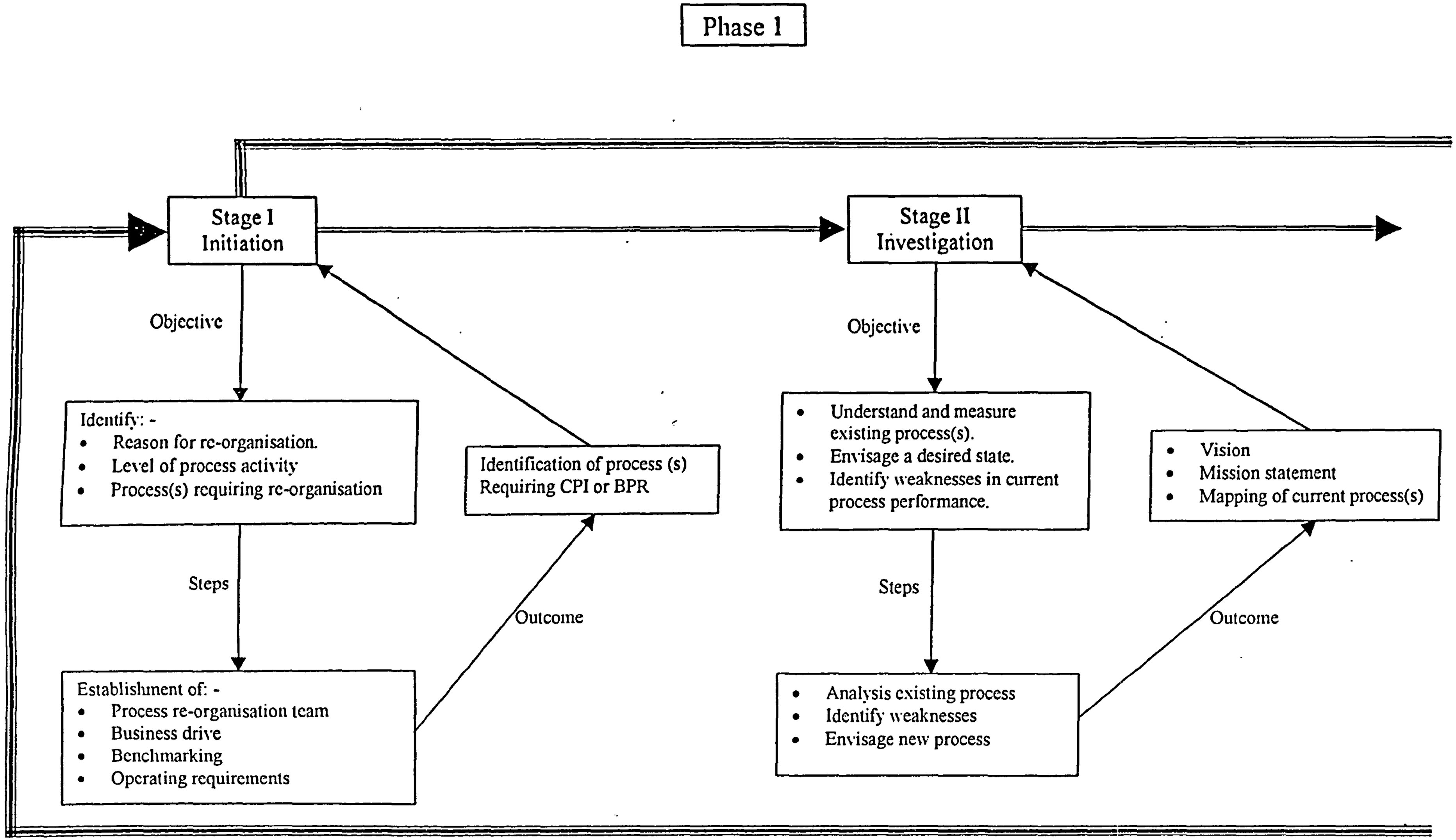
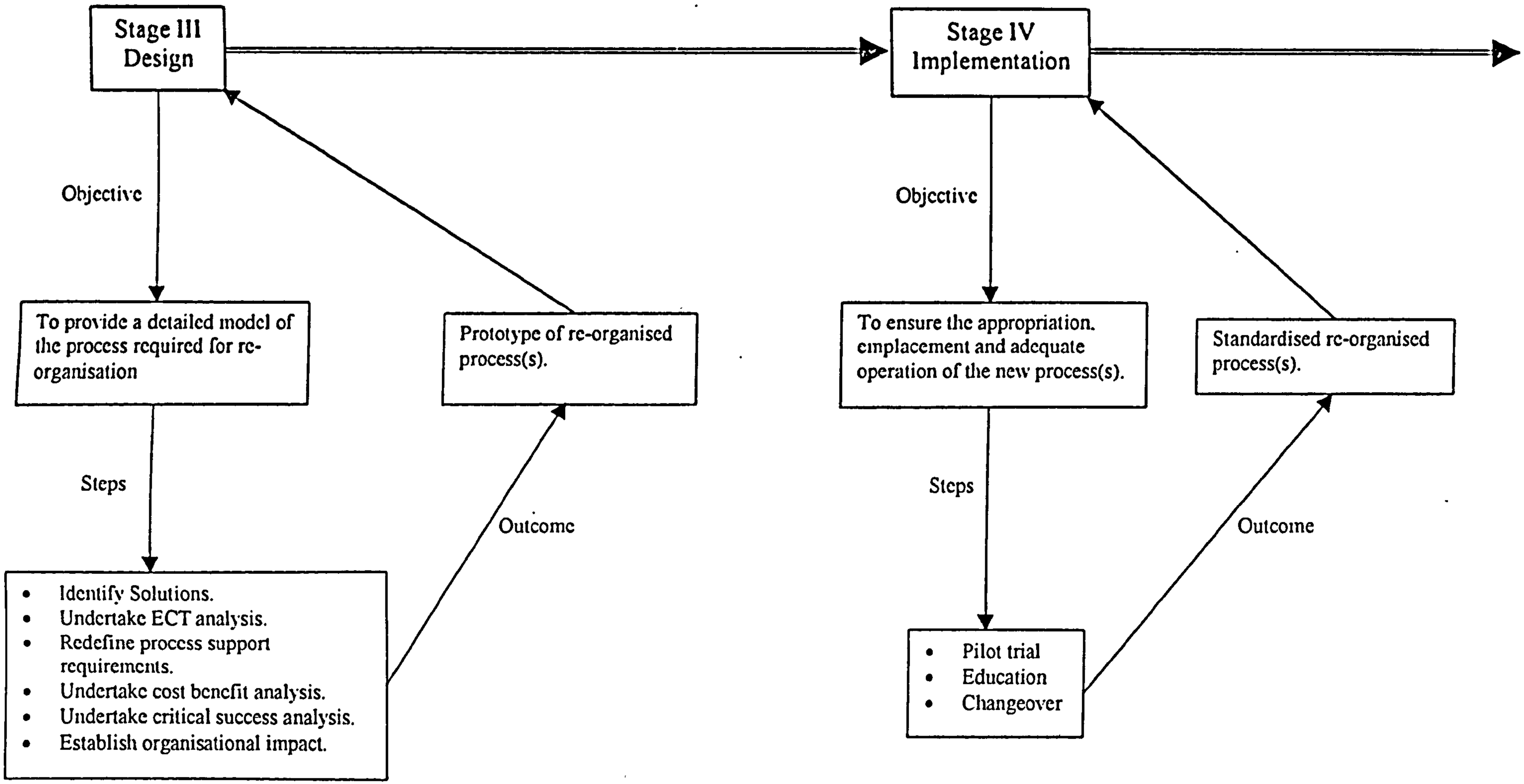
Identification of process(s) requiring CPI or BPR

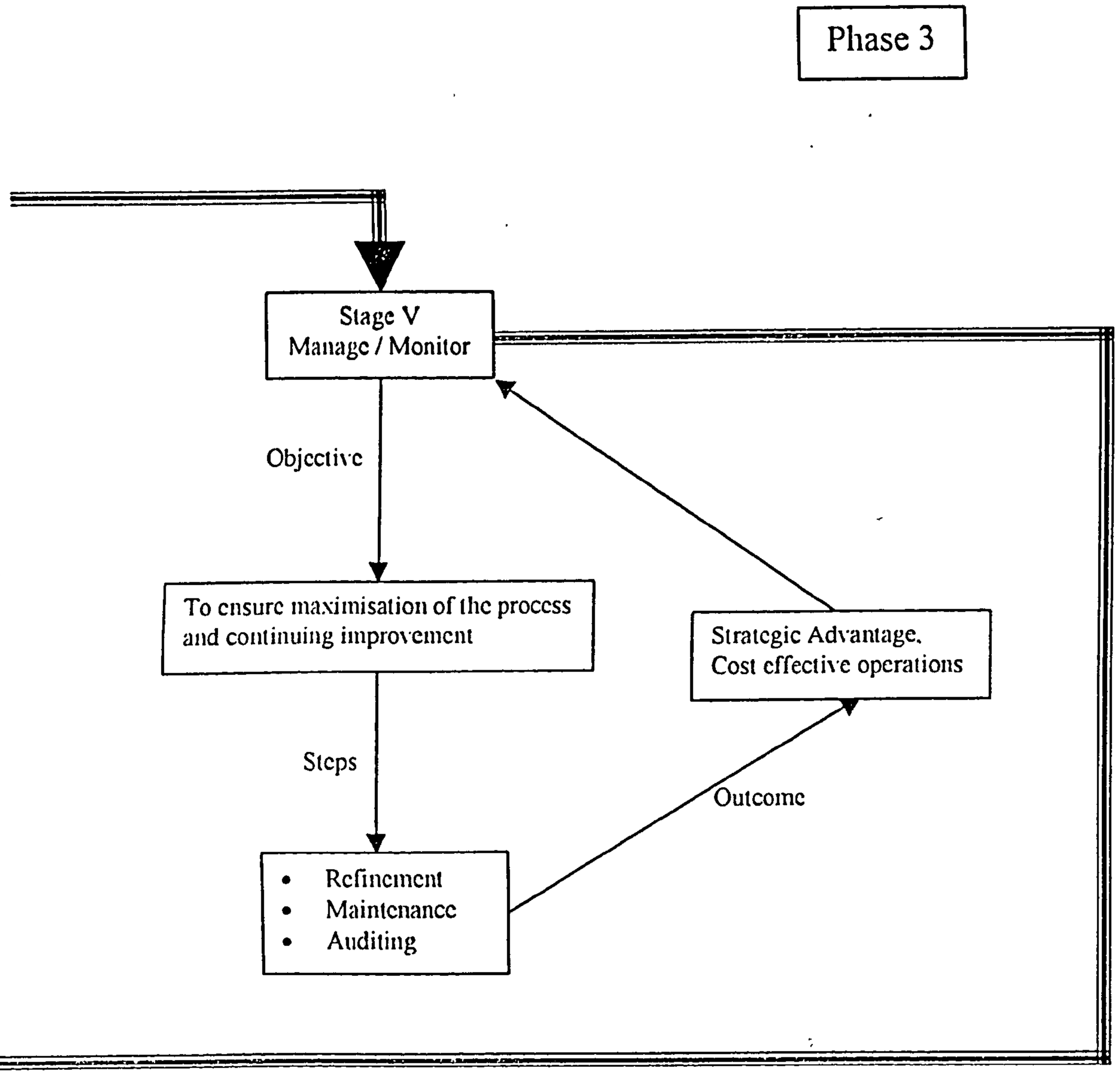


Development of plan for re-organisation

Phase 2



Continuous process improvement



The comparison of the BPR methodologies matrix.

Evaluation Criteria	Coopers and Lybrand BreakPoint BPR	Executive Systems Research Centre (ESRC)	Process Analysis and design Methodology (PADM)	ProcessWise ICL Fujitsu Ltd.	Rank Xerox (RXUK)
1. Purpose of the methodology ?					
Identify problems.	✓	✓	✓	✓	✓
Design solutions for already identified problems.	✓	✓	✓	✓	✓
Implement an already designed solution.	✓	✓		✓	✓
Includes continuous process improvement	✓			✓	✓
2. Scope or effect of the methodology ?					
Small scale project	✓	✓	✓	✓	✓
Medium scale project	✓	✓	✓	✓	✓
Large scale project	✓			✓	✓
Formal project evaluation structure	✓	✓	✓	✓	✓
Informal project evaluation structure					
3. Development life cycle ?					
Sequential		✓			
Iterative	✓		✓	✓	✓
4. Methodology steps well defined ?					
Step is well defined with clear instructions, tips and techniques	✓	✓	✓	✓	✓
Input to step is defined with possible examples	✓	✓	✓	✓	✓
Outputs or products of step are defined with possible examples	✓	✓	✓	✓	✓
Roles and responsibilities in the execution of step are well defined	✓	✓	✓	✓	✓
Quality assurance guidelines and instructions included	✓			✓	✓
5. Description of the problem situation ?					
Identifies the level of understanding the client has of the problem situation.	✓	✓	✓	✓	✓
Identifies the degree of conflict between the methodology user regarding the problem situation.	✓	✓	✓	✓	✓
Identifies what grasp the client has of the problem situations.	✓	✓	✓	✓	✓
help to identify the problem owner.	✓	✓	✓	✓	✓

Evaluation Criteria	Coopers and Lybrand BreakPoint BPR	Executive Systems Research Centre (ESRC)	Process Analysis and design Methodology (PADM)	ProcessWise ICL Fujitsu Ltd.	Rank Xerox (RXUK)
5. Description of the problem situation ?					
Identifies what type of situation the methodology users are facing.	✓	✓		✓	✓
Identifies how well structured the situations are.	✓	✓	✓	✓	✓
Identifies how the methodology users are to assess the situations they face.	✓	✓	✓	✓	✓
6. Identifies situations in which it can be used ?					
Situations for transformation	✓	✓	✓	✓	✓
Are these claims justified	✓	✓	✓	✓	✓
Any evidence & explanations offered	✓	✓	✓	✓	✓
7. Identification of boundaries for each process ?					
Boundaries established.	✓	✓	✓	✓	✓
Specific assistance provided	✓	✓	✓	✓	✓
8. Types of analysis undertaken ?					
Cost & Benefit analysis (CBA),	✓	✓	✓	✓	✓
Critical success factors (CSF).	✓	✓	✓	✓	✓
Strength, weakness, opportunity and threat (SWOT).	✓	✓	✓	✓	✓
Strategic bench marking (SBM)	✓				
Value analysis (VA)	✓				✓
9. Assessment of specific technology environments ?					
Electronic Communications Technology	✓			✓	✓
Storage and retrieval Technology	✓	✓	✓	✓	✓
Multimedia Technology	✓			✓	
Other					
10. Identification of the process team roles ?					
Role Identified	✓	✓	✓	✓	✓
Job description provided					✓
List & explanation of duties & responsibilities provided	✓	✓	✓	✓	✓
Requisite skills & education specified.	✓			✓	✓

Evaluation Criteria	Coopers and Lybrand BreakPoint BPR	Executive Systems Research Centre (ESRC)	Process Analysis and design Methodology (PADM)	ProcessWise ICL Fujitsu Ltd.	Rank Xerox (RXUK)
11. Utilisation of any of the Following tools ?					
Diagramming and Low-end BPR tools.		✓	✓		✓
Advanced simulation animation tools.					
Workflow front ends.					
Full-function BPR tools.	✓			✓	
Case, OO-modelling and Application development code generating tools.					
Others (please specify)					
12. Recognise what values the users consider as uppermost ? e.g. Economic, political, social, cultural, technical.	✓	✓	✓	✓	✓
13. Advocate any particular ethical standards ?					
Ethical standards identified	✓			✓	✓
Details of maintenance included					
Comparison with user included	✓				✓
14. Identify the level of abstract and technical thinking the user requires before they are able to practice it ?	✓			✓	✓
15. How complex is the training required for the user to fully exploit the methodology ?					
High (> 6 weeks)		✓	✓		
Medium (3-6 weeks)					
Low (< 3weeks)					
Not stated	✓			✓	✓
16. Resources are available to support the methodology ?					
Training				✓	✓
Video	✓				✓
Text	✓	✓	✓		✓
Components				courseware	
Other (please specify)					
None					

Evaluation Criteria	Coopers and Lybrand BreakPoint BPR	Executive Systems Research Centre (ESRC)	Process Analysis and design Methodology (PADM)	ProcessWise ICL Fujitsu Ltd.	Rank Xerox (RXUK)
11. Utilisation of any of the Following tools ?					
Diagramming and Low-end BPR tools.		✓	✓		✓
Advanced simulation animation tools.					
Workflow front ends.					
Full-function BPR tools.	✓			✓	
Case, OO-modelling and Application development code generating tools.					
Others (please specify)					
12. Recognise what values the users consider as uppermost ? e g. Economic, political, social, cultural, technical.	✓	✓	✓	✓	✓
13. Advocate any particular ethical standards ?					
Ethical standards identified	✓			✓	✓
Details of maintenance included					
Comparison with user included	✓				✓
14. Identify the level of abstract and technical thinking the user requires before they are able to practice it ?	✓			✓	✓
15. How complex is the training required for the user to fully exploit the methodology ?					
High (> 6 weeks)		✓	✓		
Medium (3-6 weeks)					
Low (< 3weeks)					
Not stated	✓			✓	✓
16. Resources are available to support the methodology ?					
Training				✓	✓
Video	✓				✓
Text	✓	✓	✓		✓
Components				courseware	
Other (please specify)					
None					

Evaluation Criteria	Coopers and Lybrand BreakPoint BPR	Executive Systems Research Centre (ESRC)	Process Analysis and design Methodology (PADM)	ProcessWise ICL Fujitsu Ltd.	Rank Xerox (RXUK)
17. How marketable is the methodology ?					
(i) Costs					
High	✓				✓
Medium				✓	
Low		✓	✓		
(ii) How quickly can this approach deliver the end product ?					
Fast (Within 3 weeks)					
Medium (between 3 to 6 Weeks)	✓			✓	
Slow (within 6 weeks)		✓	✓		✓
(iii) How Difficult it is to train staff ?					
Very hard (6 weeks)					
(iii) How Difficult it is to train staff ?					
Hard (4-5 weeks)					
Intermediate (3 weeks)			✓	✓	✓
Fairly easy (2 weeks)	✓	✓			
Easy (1-2 weeks)					
(iv) What kind of support is available ?					
Full	✓			✓	✓
limited					
ad hoc		✓	✓		
none					
(v) How much risk is there to adopting this approach ?					
High					
Medium					
Low	✓	✓	✓	✓	✓
18. Assistance offered to users in managing the following difficulties ?					
To engineer the participation of a wide range of organisational members	✓			✓	✓
Attempt to open up free-flow communication channels in a environment when there are already restrictions	✓	✓	✓	✓	✓

Comparison of BPR and CPI

	Consideration	CPI	BPR
1	Management Involvement	Employees at all level and emphasis on continuos incremental improvement of work processes.	Involves managers in a more 'hands on' role.
2	Intensity of team member involvement	Involves team members on an 'as needed' part time basis over extend time frame.	More intense team member involvement on a regular basis. Full time basis over condensed time frames.
3	Improvement goals	Results in the achievement of successive incremental improvement.	Periodic and focuses on achievement of dramatic improvement.
4	Implementation approach	Incremental improvements that add up to a significant improvement overall.	Focuses on outcome and a making breakthrough improvement at one time.
5	Magnitude of organisational change	Happen over an extended period. Often with limited disruption to existing jobs, management systems and organisational structures.	Radical process changes often results in changes in job. Management systems, training and retaining, organisation structure and information technology.
6	Extent of focus	Focuses on narrowly defined processes.	Focuses a broad-based cross functional processes that span the larger part of an entire organisational system.
7	Dependence upon Information systems	Occasionally find reinventing the paper trail by redesigning as form, creating a piece of correspondence etc.	Information system technology often helps to pave the way to rapid improvements in time-cycle-time reduction information access and paper trail elimination.

(Adapted from Chang, 1995)

CPI or BPR ?

Please tick appropriate box

Question 1. **Market place changes**

(a) Market place for product/services undergoing slow changes. ☐
(b) Market place for product/services undergoing rapid changes. ☐

Question 2. **Geographic spread**

(a) Housed within 1-2 physical locations. ☐
(b) Housed multiple locations and data exchange is critical ☐

Question3. **Customer/Supplier involvement**

(a) Relatively low degree of 'hands on' customer and supplier involvement desired. ☐
(b) High degree of direct involvement with key customers and suppliers. ☐

Question 4. **Cost and staffing allocation**

(a) Top management in only willing to dedicate limited financial resources and periodic part time involvement of those involved. ☐
(b) Full co-operation from management. ☐

Question 5. **Level of urgency**

(a) Organisations are relatively low on the quality improvement 'maturity curve'. ☐
(b) If an existing product/process is failing or when the situation is drastic and significant improvement must be achieved in a relatively short period of time. ☐

Results: -

Predominately **a: - CPI**
Predominately **b: - BPR**

Electronic Commerce: a consideration of implementation issues for SMEs

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ABSTRACT *This paper describes the various benefits that could be attributed to electronic commerce technologies, especially Electronic Data Interchange, as an effective tool in an enterprise's competitive strategy. From an extensive literature review, the underlying reasons why small-to-medium size enterprises are unwilling to implement such technologies are outlined. The paper also attempts to highlight the major components that contribute to the slow rate of acceptance of electronic commerce technologies, and the benefits which enterprises stand to gain from their widespread adoption. The paper also strives to provoke debate in this area with a view to encouraging further research on the topic.*

Introduction

This paper results from an extensive literature review which was undertaken as the initial part of a research programme evaluating the impact of Electronic Communications Technology on business organisations and processes.

Electronic commerce (EC) can be defined as '... the electronic exchange of all information needed to carry out inter-organisational transactions, which are specified predominately by structure and standards' (Cameron, 1994) or more simply as 'doing business electronically' (Cevik, 1995). Hence it is the paperless exchange of business information using electronic data interchange (EDI), electronic mail (E-Mail), Electronic Bulletin Boards (BBS), Electronic Funds Transfer (EFT), and other similar technologies.

It has been suggested that many companies are aware of the possibilities that electronic commerce can provide, but are afraid to adopt it as a medium for doing business (Bradeško, 1995). The reluctance of SMEs to implement electronic commerce technologies such as EDI has been widely documented (Garcia-Sierra *et al.*, 1994; Hoogeweegen & Wagenaar, 1995; Meier & Suhl, 1995; Gebauer, 1995; Parker & Swatman, 1995).

SMEs are a major and growing provider of employment and can play a vital role in economic regeneration (Beaver & Harris, 1995). They will quickly fail if they do not perceive or acknowledge the impact that environmental change has on their business (Kitchen & Proctor, 1995). Hence, in order to optimise both business development and competitive advantage, it is of paramount importance that the contribution of contemporary, relevant and focused technologies which enable Electronic Commerce (EC) are maximised

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The Benefits of ECT to SMEs

The benefits attributable to ECT are not limited to the replacement of the inefficient and costly paper-based document flows within and between organisations as may well be assumed by SMEs. For instance TNT (International parcel delivery operators) have successfully used EDI to replace their debt payment system by linking with their debt collecting partners, Dun and Bradstreet, who until recently took delivery of TNT's debtor information once a week, and its debt placement service collected the debt accordingly. This had the disadvantage of high administrative costs and additional unnecessary debtor days. Since implementing EDI, both partners have been able to obtain information daily without the need for administrative staff on each side to monitor the process. This has resulted in less time being needed in collecting payments, considerable reduction in overheads and has provided the ability to maintain better control.

Oganisations can reap more significant benefits from these technologies when viewed as strategic resources (Pickerill, 1993), even standard Information Technology (IT) applications, when accompanied by corresponding changes in internal business processes, can result in significant advantages (Venkatraman, 1994; Grover *et al.*, 1994). Electronic commerce can enhance business processes and improve internal communications for a single enterprise or it can be applied on an enterprise-wide basis (Hudson, 1995). Automobile Association Insurance (AAI) has recently finished a seven year information system project that uses EDI to link its processing offices, 150 high street shops and the insurers for over fifty schemes. The strategic outcomes of utilising EDI included better customer services, reduction in training costs; a reduction in operating cost, automatic cross-quoting at renewal; processing capability at any terminal; and standardised documentation.

Since its inception some 50 years ago, Electronic data interchange (EDI) has matured from functioning much like a simple fax-like facility to a sophisticated electronic highway, and can now create a more efficient communication link between buyers and sellers, resulting in a strategic trading relationship. Many SMEs already use relatively standard technologies such as fax, although there are inherent problems with fax technology, for instance delivery notifications and plain paper writing are only possible on some fax machines. Also there is the need to re-enter information from a fax into a computer application capable of processing the data. Every time data is entered manually in to a system, there is a chance of error (Blum, 1990). EDI helps to eliminate these errors in information systems.

EDI is capable of providing greater efficiency and enabling the development of strategic partnerships with customers and suppliers. In the long term EDI will involve the entire trading cycle and a range of related information. In this way it is superior to fax as available purchasing time is dramatically reduced, for instance orders of small quantities can be more frequent which is consistent with Just in Time (JIT) philosophy in manufacturing and Quick Response (QR) technique in retailing.

The large range of benefits that can be accrued from EDI implementations are widely documented (Blum, 1990; Parfett, 1992; Robertson, 1992; Trauth & Thomas, 1993). Direct benefits include cost savings in personnel and paper,

SMEs owners or managers can be altered through education thereby promoting an understanding of the strategic benefits, a 'proactive' approach towards these technologies will result, including the adoption of EDI.

One popular technique that has been used world-wide to promote and educate business people and trading partners about EDI involves running seminars and disseminating printed information to highlight the benefits which can arise from utilising ECT (Harris *et al.*, 1994). However, the effectiveness of this technique could be disputed by Pfeiffer (1992) whose survey demonstrated that seminars had a minimal impact on the decision to adopt such technologies. Other factors especially pressure from major customers, were much greater determinants for adoption

Another potential promotional activity is business simulation, a laboratory-based approach that enables concepts of inter-organisational international trade using ECTs to be taught to owners or managers of SMEs. It has been suggested that business professionals acquire knowledge more effectively when they are given the opportunity to experiment with the concepts that they are anticipated to use and apply in their own companies (Hoberman & Mailick, 1992; Wagenaar, 1992; Gricar, 1992; McCubbrey & Gricer, 1994). Hence this promising laboratory-based approach enables owners or managers of SMEs to adopt a role in laboratory-based 'companies' and to trade in simulated business situation with other laboratory-based 'companies' using actual EDI software, telecommunications and private and or public infrastructure facilities. This provides hands-on experience of handling electronic commerce and has been found to be an interesting method which enhances understanding of the concept being taught (Parker & Swatman, 1995). There are obvious benefits from utilising such techniques and these may possibly be maximised even further if a hybrid of simulation and a laboratory-based teaching approach is used simultaneously; potentially providing a more effective educational and training programme.

When educating SMEs about EC implementation, the potential for failure must also be addressed. In this context it is worth considering the benefits to the management process described by Ward (1994). This process considers that Information Systems or Information Technology investments should be considered as outcomes (which will always occur) rather then benefits (which may or may not occur). This will take into account positive, negative and expected/unexpected outcomes. By considering these four aspects of what is recognised as the Benefits Management Matrix, an enterprise will improve its ability to manage benefit delivery, hence maximising the positive outcomes and minimising potential negative outcomes. This can be achieved by good management practice within SMEs and therefore used to optimise any particular investment benefits that may remain.

Conclusion

In conclusion, it can be seen that those SMEs who adopt EC can gain economic advantages over those who do not. If SMEs are to survive amongst their larger trading partners and between themselves, the implementation of ECTs such as EDI are essential. EDI has firmly established its place within many businesses and its potential as a vehicle for inter-organisation business

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An Expert System utilising Case Base Reasoning (CBR) technology, to provide assistance to small to medium size enterprise (SMEs) to analysis their requirements of electronic communication technologies (ECT).

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ABSTRACT

The emergence of new and innovative technological advances in communications is appearing at a remarkable rate and will most probably continue to do so for the foreseeable future. This consequently has ensured that Electronic Commerce (EC) is at the core of today's business practices, which in turn has prompted the use of electronic communication technology (ECT). This use of ECT has started to play an increasingly important role in the running of business processes in today's enterprise environment. The decision on which technology is appropriate and how to utilise it effectively for business practices has become more and more difficult, especially for small-to-medium sized enterprises (SMEs) due to lack of knowledge on the subject and constrained budget for acquisition of such technologies. It has therefore become important that a decision making tool in a form of an expert system is available to assist SMEs in making decisions regarding the selection of appropriate ECTs.

Case-based reasoning (CBR) forms the basis of a method for building expert systems and is a recent approach to problem solving which has grown from a specific research area to a field of widespread interest. It is a problem-solving paradigm that has the ability to utilise the specific knowledge of previous experiences. Hence, this paper presents a perspective of how the use of case-based reasoning can be developed into a decision making tool, which can be utilised by SMEs in assisting the selection of electronic communication technologies.

Keywords: Business Process Re-engineering, Case-based Reasoning, Electronic commerce, Expert system, Small to medium enterprises, Electronic communication technologies.

INTRODUCTION

Industries today are being compelled to change by either technological or socio-political developments [7]. Throughout the world, access and availability of information together with electronic communication technologies (ECT) are beginning to generate a new business paradigm. This revolution is based on effective utilisation of available communication technologies to convey information and to use it strategically; to re-organise business processes to satisfy customer perspectives; to gain competitive edge; and to accommodate, as well as respond to, changes quickly and effectively [16].

Given the high rate of change in technologies and working environments, enterprises are under increasing pressure to improve the effectiveness of their business processes [32]. Electronic commerce is at the cutting edge for business today and the factors fuelling the avid interest in electronic communication technologies run the gamut of business processes [18]. Therefore, a fundamental need of the managers who want to improve their enterprises' performance, is to know how their organisation operates. This in turn would require an understanding of their enterprise's business processes [28]. It has therefore been considered, that electronic commerce is well suited to facilitate the current re-engineering of business processes and that the broad goals of re-engineering and electronic commerce are remarkably similar.

problems in the future. Case-based reasoning favours learning from experience, since it is usually easier to learn by retaining a concrete problem solving experience than to generalise from it. Effective learning in CBR requires a well worked out set of methods in order to extract relevant knowledge from the experience, integrate a case into an existing knowledge structure, and index the case for later matching with similar cases.

The process involved in CBR can thus be represented a cyclical process, which involves the following activities: -

1. retrieve the most similar case(s);
2. reuse the case(s) to attempt to solve the problem;
3. revise the proposed solution if necessary;
4. retain the new solution as a part of a new case.

CBR AS THE BASIS FOR AN ECT ANALYSIS TOOL

The CBR represents an ideal tool for SMEs, since it can provide advice cheaply and an effective SMEs. Also the decision to use an expert system as ECT analysis tool is due to identification of the fact that SMEs are reluctant to implement ECT as a result of their lack of knowledge and their general understanding of the benefits available in this particular area [16],[1].

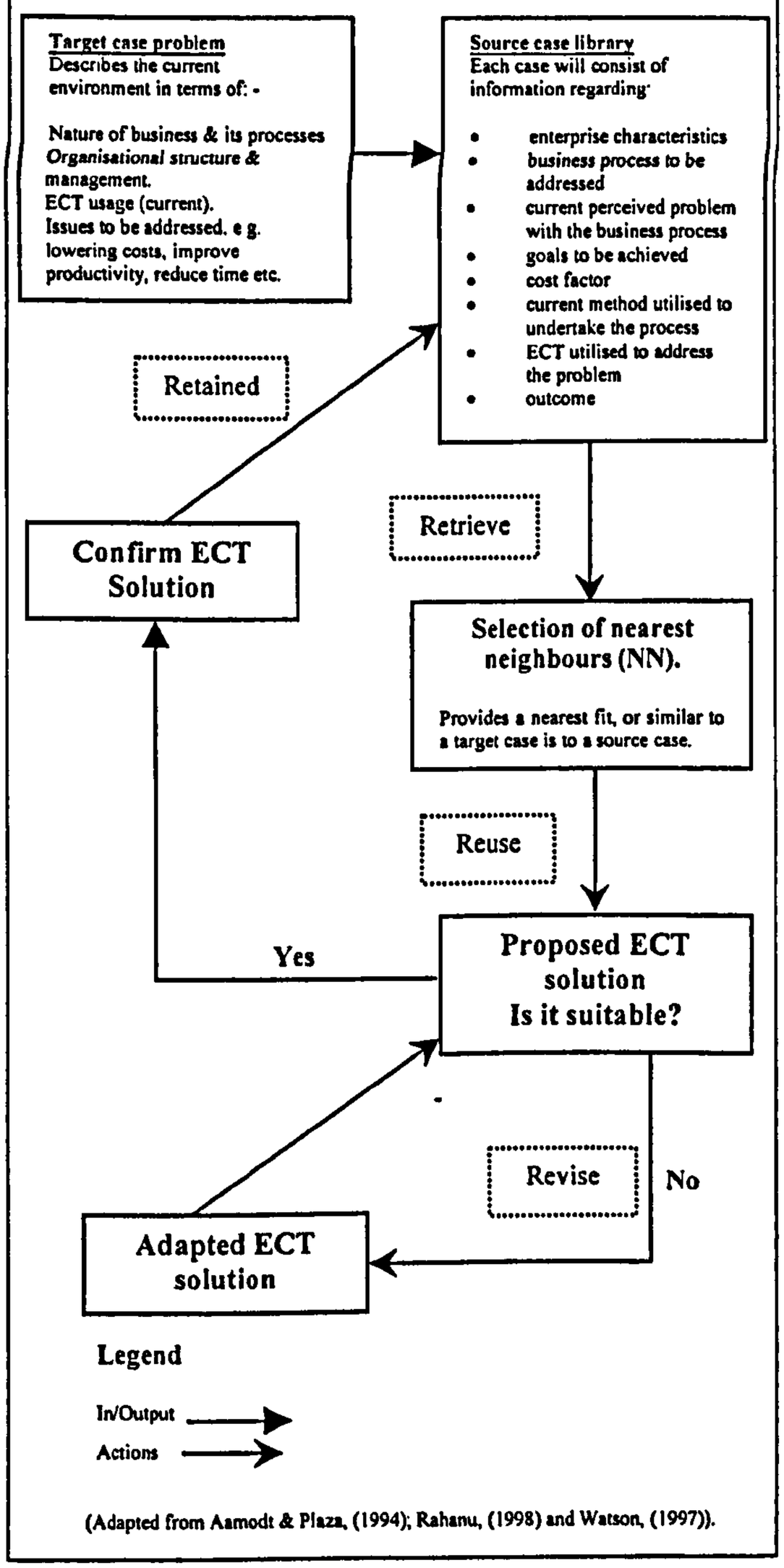
When developing CBR an appropriate tool such as an expert system shell or language needs to be selected. A case-based reasoning development shell was chosen as it enables a system to be built quickly and cost-effectively. Hence, the expert system is therefore an easy and cost-effective tool that can be used by SMEs to identify appropriate ECT and provide expert advice in this subject and hence assist in the decision making.

A detailed analysis of current literature on the development of case-based reasoning was undertaken [2],[26], and then adapted to suit the necessary criteria required developing an ECT analysis tool. The rationale of this adaptation is presented in a schematic diagram in figure 1.

SOURCE CASE LIBRARY

The first stage in developing the ECT analysis tool was to establish the source case library. This consisted of initially identifying the features that would constitute each case. The features were determined from a literature review of business practices analysed by research projects and published in various conferences, academic journals and books [4],[5],[8],[9],[13],[23]. The outcome from this review was the development of a set of questions (features), which formed the basis of selecting the cases. The cases were obtained from various publications related to the area over the last few years. It has been identified that each case should consist of a single example of the problem i.e. the problem, which describes the state of the world, when the case occurred. Its solution which states the derived solution to that problem, and its outcome which describes the state of the world after the case occurred. It is also important when determining the features that will make up the case to define those which are considered most important [2],[27],[34]. The features in this case were defined by

An ECT analysis tool Figure 1



(Adapted from Aamodt & Plaza, (1994); Rahanu, (1998) and Watson, (1997)).

the questions from the questionnaire developed from the literature review. It was decided that the key features that would make up each case in this source case library would consist of the following: -

- enterprise characteristics
- business process to be addressed
- current perceived problem with the business process
- goals to be achieved
- cost factor
- current method utilised to undertake the process

- enterprise characteristics;
- business process to be addressed;
- current perceived problem with the business process;
- goals to be achieved;
- cost factor;
- current method utilised to undertake the process.

The outcome from the case-based reasoner will be a detailed description of how the closest matching case in the library developed and implemented a strategy for utilising ECTs that could be used by the target case.

The retrieval method used is nearest neighbour matching by which cases are retrieved by comparison of a collection of weighted features (where each feature/field is given a specified relative weight, by using field importance criteria) in the current case to cases in the library. The closest matching case is retrieved. The nearest neighbour retrieval strategy is used because there is no clear solution or outcome to the problem or event, and there are few past cases available so cases whose features matched the current case the closest were needed.

Initial prototypes were developed using case-based reasoning shells, CBR Express and Remind, in order to evaluate potential technological solutions. CBR Express did not provide enough functionality, it could only provide for nearest neighbour text matching as opposed to Remind 1.1. It has the capacity to provide inductive indexing (if the problem being described has a single feature that may describe the outcome, then it is appropriate to either pure or knowledge-guided induction). Nearest neighbour (as described in the above paragraph) and template matching (this method allows to specify the dispositions of the case you want to retrieve). Remind also allows the developer a greater scope for knowledge representation and more precise indexing. However Remind's shortcoming is that it is not easily be interfaced with external applications with the comprehensive knowledge of reminds and external source coding.

Once a matching case is retrieved the CBR system will attempt to reuse the solution suggested by the retrieved case. If the solution for the retrieved case is appropriate this will be confirmed and used as required. However in certain circumstances the solution to the retrieved case may not be entirely appropriate and in this situation the CBR system must adapt the solution. Adaptation is suitable in many situations but is not essential. It has been suggested that adaptation should only be used if it can easily be carried out, using simple and well-understood parameters, adjustments or reinstantiations [34].

An alternative solution is to use the CBR to determine if a similar adaptation has been used in the past and if so, if it is utilised i.e. it will look for prominent differences between the retrieved case and the current case and then apply rules that take those differences into account when suggesting a solution. Whilst adaptation is useful in many situation, it is no means essential, hence in the case of the CBR, a person (expert in the field of ECTs) will be asked to perform the adaptation.

CONCLUSION

Technological developments, marketplace competition and business developments are all transforming the way business is running. As computing and communications converge, and as there is increasing demand for accurate and up to date information, it is essential that businesses have the best available IT and organisational infrastructure in place to realise and gain advantage. Enterprises are therefore increasingly looking for a range of solutions to either revolutionise or reform the way they do business. For many, the real concern is to not be left behind, rather than a burning desire to be a at the vanguard of change; the realisation that fundamental change is now essential to simply stay in the same relative position, not in order to be the leader. This is especially the case with communication technology amongst SMEs.

This case-based reasoner is part of a business process reengineering framework, which is specifically developed for UK's small to medium enterprises to assist them in re-organising their business processes with effective utilisation of electronic communication technologies.

The reasons that inhibiting the small to medium enterprises adopting communication technologies can be summarised as follows: -

- lack of the necessary knowledge required to implement ECT;
- lack of the necessary funds to do research prior to acquiring new technology;
- mistrust of IT vendors;
- lack of training and education in IT generally and ECT in particular.

To overcome these obstacles, it is imperative that impartial advice regarding the implementation of new communication technology is provided from independent sources. Hence, the potential for an expert system such as this case-based reasoner to promote the acceptance of ECTs by the SMEs.

This acceptance is based on the recognition that a range of organisations have successfully utilised the proposed technological solution, provide by this CBR, to maximise effectiveness of their business processes. It is also impartial advice based on previous experiences described by independent researchers and academic literature.

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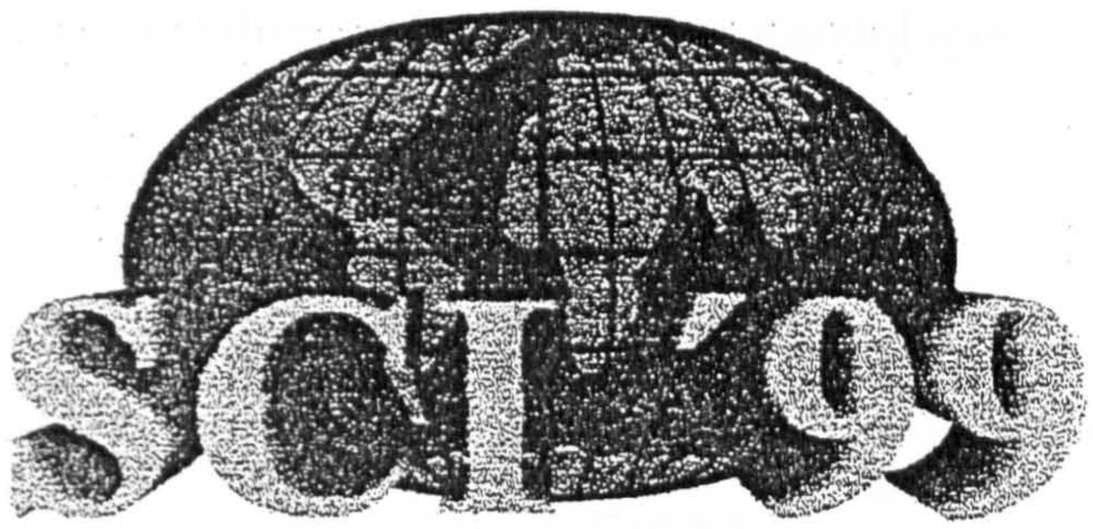

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An evaluation of BPR methodologies adopting NIMSAD a systematic framework for understanding and evaluating methodologies.

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ABSTRACT

A methodology is an explicit mechanism for helping to solve problems and recent years have seen a significant increase in the availability of Business Process Reengineering. Methodologies to enterprises. Due to such availability, it has become important to compare in order to perform classifications and to improve future methodological frameworks development. Hence, an important issue and a necessity for emerging methodologies like Business Process Re-engineering, Business Process Improvement, and Continuous Process Improvement.

A thorough survey of BPR Methodologies was conducted and five BPR methodologies were chosen because of their varying background and their claims to have successfully and radically improve the business processes whilst utilising their frameworks to carry out Business Process Re-engineering activities.

The paper attempts to provide a detailed evaluation based on important aspects concerning BPR methodologies by utilising NIMSAD framework and to provide a comprehensive analysis of the selected methodologies.

Keywords: NIMSAD, Framework, Methodologies, Business Process Re-engineering, Comparison, Formulation, Investigation, Diagnosis, Business Processes.

INTRODUCTION

The globalisation of business is affecting developed, newly industrialised and developing countries throughout the world [1]. This is due to rapid advances initiated by the use of information technologies (IT), in particular electronic communications technologies (ECTs). Therefore many organisations are trying make themselves more successful [2] by utilising these ECTs. Hence Business Process Re-engineering (BPR), Business process improvement (BPI) and Continuous Process Improvement (CPI) has become the key issue for companies to regain competitiveness and profitability in this increasingly volatile markets [3,4,5,6,7]. However these popular approaches appears to lack clearly articulated methodologies.

Recent years have seen a significant increase in the number of commercially available methodologies [8] and large number of these methodologies cover more or less the same aspects . However it has been recognised that in practice a methodological approach is often not used even though it is widely documented that during any system development it is important to employ a methodological approach [9,10,11]. Methodologies are explicit mechanisms for helping to solve problems, however once there is more than one methodology for solving similar problems, an additional problem of choice is created. It is therefore important to compare methodologies to better understand the nature of the methodologies in order to perform classifications and to improve future methodologies [12,13]. Hence comparison is an important issue and a necessity for emerging methodologies like BPR, BPI, CPI. And it will provide a shortcut means of selection and will serve to provide evidence that the initial selection was correct or that other more appropriate methodologies exist.

THE PURPOSE OF METHODOLOGY COMPARISONS

A methodology should be a formal, structured, general purpose approach to the solution of a particular type of problem [14], described as "a system of methods or of classification as it is applied by a science or art; logic, the study of procedures fundamental to the organisation of a science or a field of study" [15]. It has also been described as "a collection of procedures, techniques, tools and documentation aids, which will help the systems development in their efforts to implement a new information system [16]. In addition to a notation, process and tools, a complete methodology should provide cost estimating guidelines, utilise project management techniques and deliverables, measures and matrices, have defined forms and deliverable construction directions, include quality assurance polices and procedures outlining detailed role descriptions and training programmes and provide completely worked examples, training exercises, techniques for tailoring the method and finally detailed techniques.

There are however problems associated with methodology comparisons that have been well documented. It is near

impossible to compare all methodologies available and hence due to the restrictive nature of this it is unavoidable that information, which may be important, will be inadvertently excluded. In an attempt therefore to avoid these problems occurring, the following should be undertaken: -

i. Use an appropriate framework from which to conduct the evaluation.
ii. A thorough review and research of the methodology be undertaken including manually searching for varied terms which should then be quantified.
iii. Ensuring that the definition of methodology utilised is neither overly constrained or unconstrained.

NIMSAD - AN OVERVIEW

NIMSAD is an acronym for Normative Information Model-based System Analysis and Design and is a general framework, derived from problem solving in industry, consultancy practice and active research, which can be used for evaluating any methodology. The aims of the NIMSAD framework are to serve as a way of understanding the area of problem solving in general, help evaluate methodologies, their structure, steps, form, nature, etc and help to draw conclusions. The framework is based on four essential elements, problem situation, intended problem solver, problem-solving process and the evaluation of the three. Since the NIMSAD framework has adopted criteria, hence, five different but useful ways of undertaking methodology comparisons were considered, as outlined below:-

i. Describe the 'ideal' methodology, then compare other methodologies.
ii. Construct a 'generalised' measurement tool by selecting appropriate features from a number of existing methodologies.
iii. Test hypothesis about the features based on the study of different methodologies.
iv. Develop a common frame of reference for viewing the different methodologies.
v. Develop a contingency framework to allow the appropriate methodology to be mapped to a particular environment.

Element 1: 'The Problem situation' (methodology context). NIMSAD considers that organisations serve as the context for information systems and most problem situations occur within the organisational context. It has been recognised that problem solvers need to become competent in the understanding of organisational activities [17,18]. Hence it is important to include the 'problem situation' within the comparison framework. One of the major weaknesses of most current information systems methodologies is that they are not concerned with what really happens in organisations, however when considering BPR methodologies it is important that a understanding of the organisation is achieved first. One useful way of understanding organisations [19,20,21] is to consider them as purposeful systems i.e. designed or formed to achieve their purposes.

In the NIMSAD framework a general model is utilised to show some of the essential elements of a 'problem situation' and their formal and informal interconnections and relationships. It considers that the more knowledge that can be obtained about an organisation will result in a better understanding of the real problem present within that organisation.

Element 2: The intended problem solver (Methodology user): However powerful, useful and effective a methodology may be, the success of this will depend, among other things, on the personal characteristics of the intended problem solver i.e. the methodology user. It is important to evaluate the methodology user as this will help to understand strength and weaknesses and also assist in identifying training needs and way in which to improve competence. NIMSAD recommends evaluating the methodology user's mental construct i.e. their values, ethics, structuring process, reasoning abilities, models, frameworks and roles.

Element 3: The problem- solving process. If a methodology is to be considered as a way of problem solving, then it needs to consider the three important phases of (a) Problem Formulation (b) Solution Design and (c) Design implementation [12]. In NIMSAD these phases are divided further into eight detailed stages. These are as follows: -

1. **Phase 1: Problem formulation**
   - Stage 1: Understanding of the situation of concern.
   - Stage 2: Performing the diagnosis.
   - Stage 3: Defining the prognosis outline.
   - Stage 4: Defining problems.
   - Stage 5: Deriving notional systems.
2. **Phase 2: Solution Design**
   - Stage 6: Performing conceptual /logical design.
   - Stage 7: Performing Physical design.
3. **Phase 3: Implementation**
   - Stage 8: Implementing the designs.

PROBLEM FORMULATION

Stage 1: Understanding of the 'situation of concern'. Problem solving of the organisational kind is a complex activity and requires a good understanding of the situation of concern. To understand the situation of concern it helps to derive a boundary on the situation, thereby identifying possible areas of interest. The boundary will determine the focus of the investigation and establish the 'situation of concern' [22]. Secondly by understanding the mental construct of the problem solver it will help to determine what information to collect, as well as providing models and frameworks for determining the nature of the information collected. The richer the models and frameworks of the 'mental construct' the more rigorous the examination of the situation and the more open can become about the artificial nature of the boundary construction around the 'situation of concern' [23]. Thirdly by understanding the situation of concern will aid in selection of the most appropriate methods of investigation.

Stage 2: Performing the diagnosis. In this stage the diagnosis will reveal that the intended problem solvers understood the reasons for the state of the 'situation concern'. This will help to identify any gaps of knowledge or misunderstandings and will aid communication with the clients and problem owners, to derive agreed understanding, to clarify differences of perception and to explore the different 'world images' of the participants.

Stage 3 :Defining the prognosis. This stage is concerned with defining a desired state for the current 'situation of concern'. Failure to question the validity of the desired states' may lead to many irrelevant solutions, expensive investments and implementations and significant maintenance. At this stage the outline shape of, and the rational for, the prognosis will be defined.

Stage 4:Defining problems. During this stage the reasons why the 'desired state' can not be achieved i.e. the problems preventing the current stage from changing to the desired state. The task at this stage is to therefore identify the absence of elements and/or the current arrangement of the elements in the diagnosis model that are preventing this [24].

Stage 5: Deriving notional systems. Notional systems are those systems which need to be developed if the client organisation is to overcome the previously defined 'problems', thereby helping to transform the current state to the desired state. This stage involves the identification of the notional systems.

SOLUTION DESIGN

Stage 6: Performing conceptual/logical design. The role of conceptual/logical design is to create or make changes to the structures, roles, tasks, functions, information and attitudes of the notional system(s) [25]. During this stage it is important to consider the links between the notional systems and the 'situation of concern'. The outcome of this stage is the production of an agreed and acceptable logical design specification which states the nature and the function of the logical elements i.e. those elements that can be argued as being useful and essential to the realisation of the notional system. Once the logical components and their relationships have been designed then the methodology can progress to the physical design stage.

Stage 7: Performing the physical design. This stage concerns the deliberation and selection of 'ways and means' of realising the logical design. Through this process several physical design models can be created to realise the features of the same logical model within a given set of physical resources and constraints. The physical design process should take into account the economic, social, political, and technological and culture environments in which the proposed design models are expected to operate or perform. Additional criteria such as reliability, accuracy, safety, security, expansibility enhancability and availability should also be considered during the physical design process. The eventual prognosis model should state the particular technology to be used, input and output formats, document standards, data store organisation and access methods, layouts, persons to be involved, work procedures, documents etc.

IMPLEMENTATION

Stage 8: Implementing the designs. This stage is concerned with the realisation of the notional system within the context of the 'situation of concern'. Once this stage is completed and managed successfully, the resolution of problem issues or the measurement of success or failure of the outcome of the problem-solving process can be demonstrated. This stage will provide an opportunity to demonstrate the validity of the previously generated conceptual/logical and physical design models in practice and will assess the validity of the assumptions on which the models have been based. The major tasks of the implementation phase consists of three essential parts, the 'situation of concern'; the models generated from previous phases of the problem-solving process; and the need to find a way of bridging these two parts [26].

Finally, NIMSAD is a conceptual framework whose elements were constructed in stages to illustrate the rationale of the complete framework. The NIMSAD framework is not a methodology and should not be used for judging whether methodology steps have one-to-one mapping with the framework steps. It should be used to ask questions of the methodologies as to what elements of the framework they address, in what order and how they address them.

BPR METHODOLOGIES: AN OVERVIEW

There is wide range of methodologies that seek to consolidate into a simple framework some or all of these ideas on what should happen in re-engineering initiatives. Some methods tend to focus on the analysis and redesign tasks, others will focus on the definition of strategy or development of the underlying information systems [27]. While there are many BPR methodologies (e.g. those offered by vendors as product and by management Consultancies as a service) available, most pursue a similar path and exhibit commonality in all key areas based on the BPR model developed by Hammer & Champy [28]. Hammer and Champy were amongst the pioneers of current re-engineering concepts and even though their proposed methodology has been recognised as requiring refinement, the five broad generic steps described construe the basics of most BPR methodologies [29,30]. These steps are, define the project, (have a vision, Invent a strategy, Identify and understand the current processes), have a redesign step or "new idea" step (Redesign the processes), perform a cost/benefit analysis, plan and implement a solution (Implement the redesigned processes) and then measure the resulting performance changes. A more complete representation of the spectrum of process improvement activities is highlighted by [31].

METHODOLOGIES CHOSEN FOR COMPARISON

The following five BPR methodologies were chosen because they all claim to be able to successfully and radically improve the business processes whilst utilising their frameworks to carry out Business Process Re-engineering. The BPR methodologies included in the comparison are as follows, Coopers & Lybrand (Breakpoint), and ICL Fujitsu Ltd (Process Wise) both of which are proprietary methodologies, Rank Xerox (UK) an in-house methodology, PADM (Process Analysis and Design Methodology) and ESRC (Executive Systems Research Centre), which are both academic research based methodologies.

The Coopers & Lybrand Breakpoint BPR and the ICL Fujitsu Ltd ProcessWise BPR methodologies are commercial methodologies. The Coopers & Lybrand Breakpoint methodology has been proven to be successful in a number of well-known businesses such as Yorkshire Electricity and Levi & Strauss Co.

The ProcessWise methodology proven in its capabilities within ICL and is now commercially available to organisations. It is also semi-automated i.e. it has developed its own tools such as ProcessWise workbench to assist in the methodology process.

The Rank Xerox methodology (RXUK) is an in-house product and is not available commercially. It is a good example of how an organisation might develop it own BPR methodology and also a good example of the benefit that can be achieved through effective process re-engineering. In concrete terms the Rank Xerox BPR methodology has resulted in a more streamline efficient way of working and generated large increases in customer satisfaction. In hard financial terms the Rank Xerox UK methodology has resulted in financial savings of millions of pounds [32].

The PADM and ESRC BPR methodologies are both research based and have been developed in an academic environment as opposed to a commercial environment such as the previous three methodologies. The PADM methodology has been developed through empirical research and it has been proven to be successful in a large range of organisations. The methodology has been applied to case studies in the telecommunications sector, (a provider of telecommunications services), to the National Health Services in the UK, and within the Information Technology industry on both the service and the manufacturing side.

The ESRC methodology again is research based and has been utilised in small to medium size enterprises (SMEs) within the British Isles, where it has been proven to be successful in BPR. Amongst it successes has been a multinational company that specialises in the design and manufacturing of electronic components for the personal computer market.

In conclusion, all of the above BPR methodologies have been chosen because: -

- They have all been utilised by both large and small-to-medium sized organisations.
- They have all been proven to be successful in a number of case studies.
- They all have steps similar to those described by in the original generic model.
- They have been developed either in the commercial or academic environment and provide examples of the different types of methodology which are available.

COOPERS AND LYBRAND BREAKPOINT.

The Coopers and Lybrand organisation is one of the worlds leading practices of professional services including accounting and auditing, tax and consulting. The organisation comprises of national and international practice entities which are members of Coopers and Lybrand international, a limited liability association incorporated in Switzerland, which serve clients on a globally integrated basis in more then 120 countries [33]. Its strategic intent is to create value for its customers and to bring competitive advantage to their activities. For Cooper and Lybrand this involves the acquiring of a clear understanding of what drives competitive advantage in a particular industry; the industry's value chain and the basis for competition and how a particular company seeks to gain competitive advantage [32].

Coopers & Lybrand's BreakPoint BPR is a four-phased model/methodology that takes an interdisciplinary approach to creating breakthrough change. The C&L's four BreakPoint BPR phases are:- **Quick Assessment, Discover, Redesign, and Realise.** Each phase is then sub-divided into modules, tasks and activities.

Phase 0 - Quick Assessment, has four modules: Mobilise, Assess, Translate, Propose. These modules are then further divided into tasks, each task carrying out specific activity such as research in industry, issues, proposal and presentation to the client.

Phase 1 - Discover, has four Modules: Mobilise, Assess, Select, and Engage. Tasks include, "Initiate the Project," "Develop a Communications Strategy;" and "Select and Build Teams." Within these tasks, typical Activities would include establishing a change management team, establish a vision for the compelling need for change, and the conduct of an Organisational Culture Assessment.

Phase 2 - Redesign, is a continuation of the analysis of the selected process, the business culture and information technology applications at a more detailed level. Modules include: Mobilise, Analyse, Innovate, Engineer, and Commit. At the end of Phase 2, an implementation conference is convened to ensure commitment to organisational change.

Phase 3 - Realise, Is the realisation phase, where the project addresses changes in organisations, processes and technology and the consultancy team integrate the project components. Phase 3 Modules include: Mobilise, Communicate, Act, Measure, and Sustain. Phase 3 concludes with the transfer of ownership to provide for ongoing leadership and to enable the continuous improvement, which is critical for sustaining competitive advantage.

ProcessWise ICL FUJITSU LTD.

At the beginning of the 1990s increasing competition and falling hardware prices forced ICL to rethink their structure and business goals. The company recognised the need to diversify and to broaden its product range to include software and services. This change in emphases resulted in a major BPR exercise. Based on their expertise and experience gained in this exercise ICL produced a portfolio of products that help organisations address the issues associated with BPR [34].

The ProcessWise methodology identifies target processes and develops a strategy for redesign. It guides the Consultant and BPR project team through a series of workshops, each of these workshops attempts to captures concepts from MIT90s "Five Layer Model" [35], and relates them to the vision and objectives derived from the strategic planning for the enterprise [36]. It provides a framework in which a significant step-change in process performance can be brought about, as well as providing a means of managing continuous process improvement [37].

The improving process method consists of six phases. Phase 1 involves the identification of a strategic focus for the process improvement programme, based on the business priorities of the organisation. The objectives of this phase are to achieve an understanding of the business as it is today, the direction of the business and which areas of the business process requires' improvement. The objective of phase 2 is to identify those processes that need and are worth improving, and the determination of improvement targets. During this phase a strategy for the sequencing of process improvement is prepared and an agreement is sought requiring the breadth, depth and levels of utilisation that are applicable for the next phases. The object of phase 3 is to achieve an understanding of the current processes that are to be improved as part of the current programme, and the matrices associated with them. Phase 4 involves the redesign of the processes and further identifies opportunities using a series of structured techniques for improvement of each process. The objective of phase 5 is to establish the full impact of each process change on the organisation including what it will take to implement and its contribution to the improvement target sought. It includes an examination of strategic fit, risks and uncertainties, strategic alignment modelling and preliminary business case for change. Any differences between the current and desired situations will be identified. The final phase is that of implementation.

The ProcessWise methodology enables a structure approach, which recommends to start with a full re-engineering of the process and then maintain that process for a number of years with process management until such time as a significant change of business and environment structure justifies a new re-engineering project [37]

RANK XEROX (RXUK)

Rank Xerox founded in 1956, incorporates Xerox Corporation (51%) and the rank organisations PLC (49%). The group specialises in document management products and services and has some 100,000 employees world-wide. During the 1980s Japanese companies such Cannon and Brother were outperforming Xerox against almost every manufacturing measure, enabling them to retail products at prices equivalent to Xerox's unit manufacturing costs [32]. Xerox therefore recognised that it had to change radically if it was to survive [38]. One of the method it utilised to deliver this radical and fundamental change was Business Process Re-engineering (BPR).

Rank Xerox UK, the customer service division was one of the earliest adopters of process management within the Xerox Group during the early 1980s. It has experience of mapping, improving and redesigning processes and is currently spearheading the introduction of process management in the European arm of the business. It's first experiment in re-engineering arose when it decided to re-overhaul its "proposal to go-able order" process, which started with the issuing of a sales proposal and ran to the point where the equipment is tagged and ready for dispatch. The senior management team chose this area because the existing performance criteria of speed, accuracy, completeness, efficiency and effectiveness indicated a significant opportunity of improvement.

There are seven stages in the RXUK BPR Method, with project management and quality assurance activities operating throughout. These are as follow:- The stage initiate, is concerned with selecting processes for re-engineering, building a project organisation that engages senior management involvement, scooping the project to identify current business problems, selecting people for a project team and extracting terms of references and project objectives from the senior management team. The modelling stage is concerned with the collection of data on the business process environment paying particular attention to the customer requirements. The analysis stage is concerned with obtaining the minimal critical specification of the problems and root causes of the current state of the process. The design stage is an iterative process which concentrates on defining the content and sequence of the new work tasks, applying social system variables, and information and technology components. The pilot stage consists of testing the agreed design from the earlier stage and the implementation involves the execution of the plan from the previous stage. The final stage, the renewal stage, places its emphasis on operating the new process and feed back mechanisms that supply the data a process performance and changes in the business environment.

PROCESS ANALYSIS AND DESIGN METHODOLOGY (PADM)

The process analysis and design methodology (PADM) was developed by the information process group at Manchester University. PADM is a not a tightly prescriptive methodology, it is better described as a contingency framework which provides a battery of tools and techniques to be deployed according to the circumstances of individual process redesign projects' [5]. Case studies have an invaluable element in the development of the PADM to match the real needs of business [39].

The first phase of PADM involves establishing the objectives of a given process, a definition of its boundaries and interfaces, its main inputs outputs, those departments that are involved in executing the process, those customers that benefits from it and those that provide input. The second phase involves the modelling of the process in detail and involves the construction of a graphical representation of the process. The third phase involves techniques and criteria for analysing and assessing processes. The general aim of this stage is to look for weaknesses and problems in the process. Process evaluation is a quantitative activity and there is a strong emphasis on identifying and measuring key performance indicators. The final phase, target process design involves the design of new processes for the organisation, either by incremental improvement or radical change to the baseline processes. This phase also involves both technical and social considerations.

The methodology is expressed as a series of phases, each of which addresses a basic question, and is summarised below: -

Select process to be re-engineered: This address the basic question 'Where are we going to start?' BPR requires a global view and an integrated approach to business rather than the traditional reliance on narrow departmental specialisation. There may be several processes requiring re-engineering. However, it is necessary to focus in on a particular process to ensure that the project does not expand in many different directions. This phase ensures that such focus takes place at the outset.

Establish process team: Address the question 'Who is going to do it?' Process re-engineering is about challenging the most basic business assumptions, and may thus require significant cultural change, requiring improved leverage of people and technology operating within the appropriate structure. It is therefore vital that the process team be empowered.

Understand the current process: addresses the question 'Where do our stakeholders want us to be?' This phase involves the team acquiring a clear definition and knowledge of the current process. This requires detailed analysis of the current process, involving relevant documentation, interviews with both internal and an external personnel as customer concern concerns is vital in the current competitive business environment. The end product of this stage is a graphical model of the current process.

Develop a vision of the improved process: addresses the question 'Where do our stakeholder want us to be?' The process team at this stage looks at the graphical model of the current process, helping them to surface assumptions that needed to be challenged. To stimulate further desirable changes, existing domain knowledge is supplemented by examining of similar processes in relevant industries and perhaps from world leaders in the process. Identifying the changes required in the process and drawing up detailed and prioritised plan to move to the new process.

Identify the actions needed to move to the new process: Addresses the question 'What do we need to achieve?' A number of basic flaws had been identified in core operations related to the process being studied, and these had to be rectified at this stage. This leads to setting up audacious goals or 'stretch targets' since it is necessary to avoid a half-hearted approach being taken, whereby BPR lapses back into an incremental improvement programme without any radical substance. At this stage visible metrics are establish wherever possible to verify that the re-engineering process is meeting expectations.

Negotiate/execute a plan to accomplish these actions: Addresses the question 'How will we achieve it?' At this stage a formal presentation of the plan is conducted insuring full support of executive sponsors. Relevant support mechanisms and management processes are to be aligned for transition to new processes, thus making changeover as smooth as possible. New processes are institutionalised. Frequent monitoring to ensure that the re-engineering project does not diverge from its process vision.

The methodology has been used in several cased studies and these re-engineered process shown considerable improvements in its cost effectiveness [40].

DISCUSSION

When undertaking analyses of BPR methodologies it is important to establish what the purpose of the methodology is. This may include the simple identification of problems, the design of solutions for already identified problems, the implementation of already designed solution, continuos process improvement (CPI) of an already implemented solution or it may include all four of these elements or a combination. All of the chosen methodologies included two stages of identifying problems, and designing solutions for those identified problems. All of the methodologies with the exception of PADM also include implementation and CPI.

Attention to process is increasingly being seen as the way to improve performance and with better quality product across the whole spectrum of organisations. Hence, to maintain an atmosphere of continuos process improvement, a combination of BPR and CPI should be used as complementary approaches [7,41] to achieve breakthrough results.

Having established what the purpose of the methodology is, then it is important to determine the scope or effect the methodology is best suited for. Scope may be described in term of a number of divisions. The scope of the methodology describes the life cycle of the project. The scope of application allows the differentiation between projects for multi-site, multi-national organisations and organisations characterised by a single or small number of business sites. The scope of change relates to the improvements, which are required from the BPR project. Large business processes are recognised as being significantly more complex that smaller processes. Hence, if a methodology is best suited for large business process it should identify what mechanisms are required for accommodating it. The formality of the method should also be assessed as to whether the method could be conducted informally i.e. in an exploratory fashion or whether a more formal conducting is required. The commercial methodologies Coopers & Lybrand, ProcessWise and propriety methodology of Rank Xerox UK (RXUK) can accommodate small, medium and large business processes but the academic based researched methodologies are limited to small and medium business processes.

Understanding the development life cycle presented by the methodology is an important requirement of project planning. It also provides an indication of the completeness of the methodology. The sequential development life cycle also known as the waterfall life cycle can produce high-risk yielding or unexpected results due to prototyping rigorously step by step. This is the traditional application development methodology typically following the five-steps of planning, analysis, design and development, testing and implementation. It is a waterfall analogy i.e. once you complete one step, development moves ahead to the next. Unfortunately, this analogy breaks down when we consider the more global rate to develop applications in this mode, and that the user sign-off all good developers obtain do little to stem the current of today's rapid business change [42].

An alternative is to follow an incremented iterative approach, also called a spiral or workflow model. The method starts by looking at the business process involved and defines the roles, tasks and objects involved with those processes. The development process follows repetitive spiral cycles with useful system deliverables to the end-user from each cycle. The process is almost self-correcting for errors in definition or evolving business process changes. All of the methodologies with the exception of SERC, which is based on the sequential life cycle, have iterative life cycles.

Each methodology should describe a process, which, if followed, should yield an appropriate set for end products. The clarity of a process simplifies the execution and introduction of the process into development organisation. A well defined process (step) should have the following attributes:-

- Each step is well defined, with clear instruction, and tips and techniques mentioned where appropriate.
- The outputs, a products of each steps are defined, with possible example.
- The role(s) responsible in the execution of each step are delineated
- Quality assurance guidelines and instruction are provided

The above provides a comparison mechanism for ascertaining the completeness of each methodology. Of the methodologies chosen all incorporate the first three of the above, however only the commercially available methodologies (Coopers & Lybrand and ProcessWise) and proprietary (Rank Xerox, RXUK) includes quality insurance guidelines.

A problem situation is a situation in which a decision maker or a group of decision makers, is dissatisfied with the current situation, has alternative course of action available, can make choices which have significant effect and has some doubt as to which alternative to select [43]. It is important to create a mental model of the current problem situation, which can broadly express the actual problem situation and potential solutions.

Most problem situation are set within an organisational context, the richer the knowledge the intended problem solver can therefore obtain about the organisation, the better the position they may be in for understanding the 'real' problems of the organisation. It may also help them to make better judgements about the relevance of information to those in the 'problem situation' and ready to rise questions [12]. All of the chosen methodologies consider the problem situation in great details.

It is important to establish boundaries as these will identify possible areas of interest and will determine the focus of the investigation and establish the 'situation of concern'. However, when establishing boundaries the fact that many elements could be excluded from being considered by the subsequent steps in the problem-solving process should be taken into account. If the causes of the identified problems' lie with the elements outside the boundary then no matter how well the content of the boundary is redesigned or transformed the 'problems' will not be solved [12]. All of the methodologies establish process boundaries along with assistance for constructing these, if need arises.

Cost benefit analysis is a method used to identify, portray and assess the factors that need to be considered in making rationale economic choices [44]. It is the complete, realistic comparison of costs and resulting benefits associated with implementing a decision [7]. Cost benefit analysis provides a useful decision-making aid enabling the financial implications of new systems to be maximised. It also can be used to provide guidance on the proper timing of implementation leading to a schedule of investments which will yield the greatest overall benefit.

Analysing cost benefit data, however, can be a complicated process and should include the following four steps:

1. Clarify reengineering option.
2. Determine cost/benefit categories
3. Gather necessary data.
4. Calculate cost benefit relationship [7].

SERC, PADM and Rank Xerox RXUK methodologies use diagramming and low end BPR tools and coopers & Lybrand and ProcessWise utilise full function BPR tools. The use of other tools were not mentioned.

However powerful, useful and effective a methodology may be, the success of effective and efficient process re-design and successful implementation depend among other things, on the personal characteristics of the intend problem solver. Changing values and beliefs is one of the most important aspects of any serious attempts to transform business performance [54].

Values are beliefs that we consider to be 'good' without question. We tend to inherit from our parents, peer groups and media, and from our own life experiences and observations. Therefore values help us to pass judgement on situations or to assess the actions, behaviour, output and performance of others. Depending which values (e.g. economic, political, social, cultural, or technical) will dominate, this in turn will determine our judgements which are passed on to a particular situation. e.g. An intended problem solver who holds economic values as uppermost may consider a situation of interactions of a large number of employees to be highly wasteful and inefficient. This same situation however may be perceived by an intended problem solver with social values to be highly effective [12]. All of the methodologies take into consideration the values that the user consider as the most important e.g. economic, political, social etc.

Ethics relate to the standards which we and other place on a persons' expected behaviour. Professional institutes, stakeholders, organisations culture and one's own values also dictate what ethical norms and standards must be followed in a given situation [55]. Some consultants describe ethics as the threshold beyond which they would not be prepared to act, thus implying a minimal and tolerable limit for the expected behaviour [56]. Ethical standards were only considered within commercial and proprietary methodologies.

Knowledge and skills are acquired from education, training and experience. These are essential if we are able to undertake any transformation of a situation. It is therefore important to address how much training will be required for the user to exploit the methodology fully. Having determined how much training is required it is also important for methodology's to offer tools to support the methodology. Only the Coopers & Lybrand, ProcessWise and Rank Xerox RXUK methodologies identify the level of abstract thinking the user requires before they are able to practice the method. The complexity of training was only mentioned in two of the methods. Both SERC and PADM require between 3-6 weeks of training for the user to fully exploit the methodology.

The marketability of something is a measure of how easily it can be sold, introduced and adopted by a organisation. Certain questions should therefore be asked of a methodology to ascertain its marketability:-

- How quickly can the methodology deliver the end-results/products.
- How much will it cost.
- How difficult will it be to train staff.
- What will the impact be on project plans and how will people be trained to use this approach.
- How much risk is there in adopting the approach.
- Will any existing skills be affected and if so how many new skills and tools will need to be learnt.

By evaluating these concerns the initiator of the technology adoption can prepare a strategy to evaluate and assess the appropriateness of a new method for their organisation. The marketability, and eventual selection of any methodology for an organisation is very dependent on the current status and direction of the organisation.

All of the methodologies were quite similar in their Marketability. The cost however did vary amongst the methodologies. The Coopers & Lybrand was the most expensive, and ProcessWise falling into middle price range. There was no price listing for Rank Xerox RXUK, It is solely for in-house use. The cheapest were the academic based researched methodologies of SERC and PADM.

All of the methodologies attempt to open up free-flow common channel in an environment where there are already restriction. Cooper & Lybrand, ProcessWise and Rank Xerox also engineer the participation of a wide range of organisational members.

CONCLUSION

It is important to compare methodologies to better understand the nature of the methodologies in order to perform classification and to improve future methodologies. It can be seen from this methodology comparison that the strongest methodologies in all aspect of BPR are those of the commercially available methodologies in particular Coopers & Lybrand and ProcessWise. These however also are the most expensive of all of the methodologies under review.

The cheaper of the methodologies SERC and PADM, which would probably be more reasonable for SMEs to use unfortunately, is weak many areas. If we are to therefore encourage SMEs to undertake BPR and incorporate technologies such as electronic commerce and Multimedia technologies it is important that a reasonably cheap thorough and easy BPR methodology is available to guide the owners through these changes.

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A critical success factor (CSF) analysis aims to describe "the essential conditions" for the business to achieve its objectives [45]. There are eight generic CSFs which have been recognised for implementing BPR [29]:-

1. A Strategic purpose for BR should be established
2. A commitment to BR from senior management is needed
3. Targets (or goals) should be clearly defined
4. Business core processes should be defined
5. Process owners should be appointed prior to BR redesign
6. Process owners should manage the change process
7. Systems should be established to ensure that staff work together
8. Senior management should ensure stakeholder involvement

The Strength, weakness, opportunities and threat (SWOT) analysis can be simply understood as the examination of an organisation's internal strengths and weaknesses and its environments opportunities and threats [46]. It is a general tool designed to be used in the preliminary stages of decision making and as a procured to strategy planning in various kinds of applications [47]. An understanding of threats and opportunities coupled with an examination of strengths and weaknesses assists in forming a vision of the future. Such foresight would translate to initiating competent programmes or replacing redundant, irrelevant programmes with innovative and relevant ones

Benchmarking has evolved from a clear-cut measurement techniques to a strategic management approach. It is no longer a short-term and problem-oriented project but a continuous process [48,49]. Benchmarking involves learning and discovering how other work groups within an organisation perform common processes or how other competitive or world class organisations operate. Benchmarking is especially critical to any process-reengineering effort, because it provides goals to shoot for and aids in helping you envisage and design your new process [7,49]. Good benchmarking typically employs a step-by-step approach with a benchmarking team who are responsible for planning the study, find the benchmarking partners, observing and documenting the partner's processes, identifying performance gaps and their root causes, and choosing the best practices that are then to be adopted and implemented in the organisation [48].

All of the mentioned methodologies undertake a cost-benefit analysis, CSF analysis and SWOT analysis. However, only the Coopers & Lybrand methodology includes strategic bench marking and only Rank Xerox and Coopers & Lybrand methodologies incorporates a Value analysis.

Electronic commerce (EC) can be defined as "... the electronic exchange of all information needed to carry out inter-organisational transactions, which are specified predominately by structure and standards" or more simply as "doing business electronically" [49,50]. Technologies such as Electronic Data Interchange (EDI) and Electronic Mail (e-mail) have been widely used for years in work-flow and reengineering applications. [51]. EDI in particular has been used as a enabling tool as a lever for re-designing business processes rather than being overlaid on existing system [52].

The convergence of four industries, the computer, TV and broadcasting, telecommunications and Print/Publishing industries into a multimedia industry has brought about much turbulence into the organisational domain resulting in considerable organisational redesign. Of the methodologies chosen the only specific technology environment assessed by all of the methodologies is that of storage and retrieval. All of the methodologies undertook an Information technology (IT) analysis within which they may or may not have include electronic communication technologies analysis. This however was not evident in the chosen case studies. However from the recent trend in available technologies in specific multimedia technologies, it is evident that the commercial based methodologies have adopted it in their analysis of available new technologies.

The true starting point of a process reengineering effort is putting together a team of people who will drive the effort [7]. The responsibilities involved in a business re-engineering development effort require some delineation. Ideally each required role should be elaborated with a summery, job description, a list and explanation of duties and responsibilities, and the requisite skills and education specified.

The selection of team participants should result in a balance of both project management and creative skill factors such as:-

- Should there be an interim team with the mandate of looking at the need for re-engineering first?
- Should the team manage the process reengineering effort from beginning to end?
- Should team member be assigned to the team for the entire duration or just come and go as needed etc. need to be considered when selecting a team [7].

The participants which should be involved in a BPR project include; a senior management sponsor, head of key functions (which a business process interests) and representatives form IT, human resources and financial functions. All of the methodologies identify the process teams roles and provides lists and explanations of the duties and responsibilities. A job description is however only provided within the Rank Xerox RXUK method and Coopers & Lybrand, ProcessWise and Rank Xerox RXUK also specify the requisite skills and education needed.

There are more than sixty tool vendors in what is estimated to be hundred million pounds' market growing at 40% per year [53]. The market for BPR tools will continue to grow on average 30-40% per year through the year 2000 as the need for quantitative empirical and shareable tools continues to increase. BPR project should follow a proven BPR methodology that specifies the use of particular techniques, such as activity based costing or simulation. These technique requirements should be used to drive the BPR tool buying decision.

The Gartner group has divided the BPR tools market into five categories:-

1. Diagramming and low-end BPR tools:- These tools provide strong diagramming capability and often an underlying data model for capturing metrics.
2. Advanced simulation/animation tools:- These tools are generally expensive and offer 'industrial strength' simulation via graphical development, programming languages, vertical industry library routines and 3-D graphics.
3. Workflow front Ends:- These tools are often simply visual development environments for workflow tools. They tend to be easy to use but analysis capability tend to be weak.
4. Full-function BPR tools:- These tools include characteristics of multi-user capability, methodology support, link to AD and more capable analysis and simulation/animation.
5. Case, OO-modelling and AD code generating tools:- Many case-tool vendors are now offering BPR capability that is either stand alone or integrated with their case tools. These tools often offer strong repository support and possibly code generation capability.

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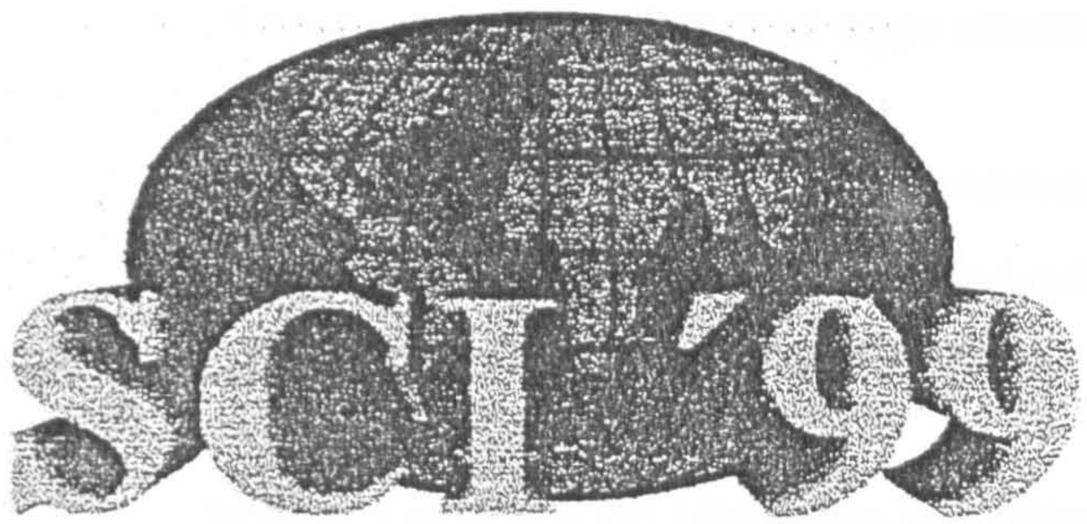

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A matrix of evaluation and comparison of Case-Based Reasoning (CBR) software tools to facilitate understanding and appreciation.

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ABSTRACT

Case-based Reasoning software tools have made the Case-based Reasoning theory particularly feasible in recent years and have driven the current surge in interest within this domain of Artificial Intelligence.

There are currently several Case-based Reasoning software tools on the market. These may be from academic research projects or from well-known software development houses in the field of Artificial Intelligence. They offer basic to advanced development techniques within the Case-based Reasoning environment cycle. For research purposes a number of Case-based Reasoning tools were selected on the basis of those most widely used and currently available in both the academic and commercial market place.

The paper provides a detailed matrix based on important criteria that correspond to the evaluation of these Case-based Reasoning tools.

1. INTRODUCTION

Knowledge-based expert systems (KBES) are one of the success stories of Artificial Intelligence (AI) research [1], [2]. However, despite the undoubted success of model-based KBES in many sectors, developers of these systems have met several problems [3], [4], [5], [6], [7]. In recent years an alternative reasoning paradigm and computational problem solving method that seems to address the problems identified above has increasingly attracted attention. Case-Based reasoning (CBR) solves new problems by adapting previously successful solutions to similar problems [5], [8], [9], [10], [11].

CBR software tools have made the CBR theor substantially feasible in recent years and have driven th current surge in interest within this domain of Artificia Intelligence (AI) [12], [13]. This problem-solvin domain is entering a period where particular researcher and commercial users are exploring its potential and it limitations [14]. Hence, evaluation and comparison ha become a necessity for such an emerging technology.

In recent years several events and introductory article have demonstrated prototypes and commerciall available CBR software tools. Such events and article have allowed the assessment of the underlyin technology up to a certain degree [15]. Howeve technological improvement in terms of computationa power, Graphical User Interface (GUI), etc and th availability of more up-to-date CBR software too utilising these improved technologies have prompted a updated, detailed, comprehensive evaluation an comparison.

There are currently several CBR software tools on th market. They offer basic to advanced developmer techniques within the CBR environment cycle. Fo research purposes a selection of CBR tools was made o the basis of those most widely used and currentl available in both the academic and commercial mark place. These are CBR-Express. CasePoint. ReMin ART*Enterprise and ReCall. These tools have bee widely used in the development of both academic an commercially available CBRs.

The paper attempts to provide a detailed matrix based o important criteria that correspond to the evaluation these CBR tools. The idea is to use technically an ergonomically oriented criteria [6]. These criteria a used to describe the capabilities of the case-base

will result from outlying cases. This may be resolved by removing these cases or by obtaining more cases to improve the coverage for that feature. Features may also be combined or divided.

If a feature is to be used as the outcome of inductive retrieval it is important to check its distribution carefully to ensure that cases cover that feature value at regular intervals. If a feature shift is noted in the case-base particular attention should be made to the case coverage around the area of the shift. The CBR tool should provide these facilities within its system development environment.

3. THE QUALITATIVE CRITERIA

The qualitative analysis assesses which elements the CBR tool, under investigation, contain. The following criteria should be used to obtain information regarding the technical and ergonomically orientated issues of the CBR tool.

4. TECHNICALLY ORIENTATED CRITERIA

Case and knowledge representation.
Cases can be represented in a variety of forms. These utilise the full range of AI representation formalisms such as frames, object predicate, semantic nets and rules [16]. The most popular currently are frames and object being applied by the majority of CBR tools.

Organisation of the case library.
The simplest structures for organisations of case libraries are: - flat memory, shared feature networks, prioritised discrimination networks, redundant discrimination networks and hierarchical memory [17].

(i) **Flat memory- serial search.**
This is easy to implement and allows a full search of the case library. However as the library gets larger, some means of partitioning it must be used to make search algorithms efficient or the case library slows down [8]

(ii) **Shared feature networks.**
This is more efficient than a serial search as the case library is partitioned according to the size of the sets of features shared by cases. However, the network must be prioritised to ensure that well matched cases are not overlooked. Unfortunately, as the library of cases gets larger the search becomes less and less efficient as it becomes harder to maintain an optimal share-feature network and matching becomes more complex. [18].

(iii) **Prioritised discrimination networks.**
Efficiency is improved through the subdivision of the case library one dimension at a time.
The most important dimensions are divided first. However, this system has the main features in a probe e.g. new situation. If systems cases are used for different tasks then different networks, which have been prioritised differently, may be required [8].

(iv) **Redundant discrimination networks.**
These networks have the ability to deal with missing feature problems. This is achieved by multiple discrimination being performed during each level of the network. Retrieval, however, may be less accurate because in addition to the best-matched cases being found they also return barley-matched cases. In addition, therefore, a second phase of matching must be performed to ensure the best case is chosen from those returned by the search algorithms. [19].

(v) **Hierarchical memory**
These have the ability to interact with dimensional and aggregate matching functions depending on the indexing utilised [20].

Similarity assessment.
There are many methods for assessing similarity [21], [22]. These may include: -

(i) **Nearest neighbour.**
Similarity between stored cases and new input cases are assessed by matching a weighted sum of features. Problems associated with this approach include determining the weights of the features, converging on the correct solution and retrieval time, which increases linearly with the number of cases. This method is therefore best suited when the case base is relatively small. [23], 24], [13].

(ii) **Induction.**
Induction algorithms such as ID3 determine which features do the best job id discriminating cases, and generate a decision tree type structure to organise the cases in memory. [18].
This approach is best suited when a single case feature is required as a solution, and where it is dependent on others.

(iii) **Knowledge guided induction.**
Knowledge to the induction process is applied by manually identifying case features that are known or thought to affect the primary case feature. This approach often needs to be used in conjunction with others because the explanatory knowledge is not always readily available for larger case basses.

(iv) **Template retrieval.**
This method returns all cases that fit within certain parameters. It is similar to SQL- like queries and is often used before other methods to limit the search space to relevant sections of the case-base.

Handling of noisy and incomplete data.
Testing and training of a case library must be undertaken to identify gaps in the case library and expose inadequacies in the contents of the original cases and indexing scheme.

When gaps are identified the library must be enhanced with cases to fill these gaps. Inadequacy of the indexing

system will result in the failure to retrieve cases that are most appropriate for solving a new problem resulting in a poor solution [25]. Refining of the indexes or such cases should therefore be undertaken.

Inadequate contents of cases will result in the reasoner being provided with incomplete advice on how to solve the problem. This also requires refinement of the individual faulty cases.

Performance

Performance is measured with regards to the speed of retrieval of a matching case from the case library and the measurement of closeness of a retrieved case to a current case. The speed of retrieval is dependent upon the number of cases in the case library. For instance, the performance of the nearest neighbour matching method decreases substantially as the case library acquires more cases. Regarding the measurement of closeness the larger the case library then greater the probability that a case retrieved for a current case will match with a relatively high measurement of closeness.

5. ERGONOMICALLY ORIENTATED CRITERION

Each CBR tool was evaluated for its performance. This involves the analysis of each ergonomically orientated criterion such as: -

(i). **Control of application development.**
More often than not a case-based reasoning tool offers a development methodology which directs the development of an application. Each stage of the CBR methodology can be controlled and supported by editors, for example, Cognitive Sciences' ReMind has a set of associated editors for each phase of its development methodology. An advanced methodology will consist of the following phases: -

- Establish case representation
- Enter cases
- Specify index parameters / index cases
- Build adaptation rules
- Customise interface
- Retrieve cases and
- Create additional views

Each phase should be controlled and supported by automated tools supplied by the CBR tool.

(ii). **Validating and testing of the application system.**
This involves two processes, verification (building the system right) and validation (building the right system). Having established that the system is the one the users want, it needs to be verified that it correctly solves the problem identified.
The CBR tools, which allow verifying a traditional role-based system, should allow a check for duplications, inconsistencies, omissions and isolation. The CBR tools should also provide the facilities for a comparison of the performance of the system on test problems to that of expert. A monitoring of such processing should be available from the CBR tools to provide an output to the developer. Similar verification checks can be made on CBR systems; however this is more difficult to perform. CBR systems are dynamic and add cases to the case-base as the system learns. Systems performance will consequently change over time and verification results will almost always be affected by learning. The CBR tools should provide the facilities to accommodate the above.

(iii). **Acquisition and maintenance of Knowledge and data.**
Maintenance of case libraries is essential to ensure the discovery of inaccurate indexes, incomplete cases, or missing coverage (Coenen, 1992). These problems may occur as a result of the encounter of novel situations that were not present during initial testing. The purpose to which the system was developed may evolve and there may be a change in the nature of experiences in the domain the library is associated with over time [26].

(iv). **Explain ability and modelling support.**
This primarily investigates the features of CBR tools that support the developer in designing good case bases. Tools can be provided to identify if there is already a case in existence that is very similar and after which support for determining case distribution.

(v). **User acceptance.**
User opinions should be considered at regular intervals to ensure they are happy with the system. As systems grow in size and accuracy, retrieval speed is often compromised and often user's perception of the system's performance is closely linked to the retrieval speed.

6. CONCLUSIONS

We have presented in this paper a detailed matrix based on important criteria that correspond to the evaluation of these CBR tools. The idea was to use technically and ergonomically oriented criteria. These criteria were used to describe the capabilities of the case-based reasoning tools and, thus, allow the comparison of different tools.

For research purposes a selection of CBR tools was made on the basis of those most widely used and currently available in both the academic and commercial market place. These were CBR-Express, CasePoint, ReMind, ART*Enterprise and ReCall.

The results highlight that the choice of tool is very much dependent upon the type of application being developed. For instance, relatively simple applications such as help desk applications are best developed using CBR-Express. This is because CBR-Express has a simple case structure and uses text based nearest neighbour matching. On the other hand tools such as ReMind provide more functionality that allows developers to develop relatively more sophisticated applications. ReMind is a flexible tool offering the widest range of retrieval methods along with interesting concepts such as qualitative models and visual adaptation formulae.

However, it does not have the powerful text handling features of Inference's products (CBR-Express and CasePoint).

In addition, the results highlight that the choice of tool is also very much dependent upon the skills and experience of the developer in developing CBR applications. CBR-Express and CasePoint use an interface that deals with all programming elements of case creation and editing resulting in a syntax free environment that allow people without programming skills quickly develop case-based reasoning systems.

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A matrix of evaluation and comparison of Case-Based Reasoning (CBR) software tools					
CBR tools	**CBR-Express**	**CasePoint**	**ReMind**	**ART*Enterprise**	**ReCall**
Evaluation Criteria					
Quantitative Criteria					
Correctness	✓	✓	✓	✓	✓
Consistency	Not enforced	Not enforced	Enforced	Enforced	Enforced
Performance	×	×	×	×	×
Noise & Incompleteness					
Numerical features	Low	Low	High	Medium	High
Symbolic features	Medium	Medium	High	Medium	High
Qualitative Criteria					
Technically oriented criteria					
Case and knowledge representation	Object oriented	Object oriented	Object oriented	Object oriented	Object oriented
Organisation of the case library					
Flat memory –serial search	✓	✓	✓	✓	✓
Shared feature networks	×	×	✓	✓	✓
Prioritised discrimination networks	×	×	✓	✓	✓
Redundant discrimination networks	×	×	✓	✓	✓
Hierarchical memory	✓	✓	✓	✓	✓
Similarity assessment					
Nearest neighbour	✓	✓	✓	✓	✓
Induction	×	×	✓	×	✓
Knowledge guided induction	×	×	✓	✓	×
Template retrieval	×	×	✓	✓	×
Handling of noisy and incomplete data	✓	✓	✓	✓	✓
Performance	Medium	Medium	High	High	Medium
Ergonomically Oriented Criteria					
Control of application development	Partial	Partial	Partial	Partial	Full
Validating and testing of the application system					
Verification	✓	✓	✓	✓	✓
Validation	✓	✓	✓	✓	✓
Acquisition and maintenance of knowledge and data	✓	✓	✓	✓	✓
Explain ability and modelling support	Partial	Partial	Full	Full	Full
User acceptance	Full	Full	Partial	Partial	Partial

Legends

Yes = ✓ No = × Low = to a relatively small extent Medium = to an intermediate extent
High = to relative large extent Full = to a maximum level Partial = Intermediate level (limited)